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ANNALS of SURGERY

VOL. LXXX DECEMBER, 1924 No. 6

ARTERIOVENOUS ANEURISM

CLINICAL EVIDENCE CORRELATING SIZE OF FISTULA WITH CHANGES IN THE HEART AND PROXIMAL VESSELS

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FROM THE SURGICAL SERVICE OF HARVEY CUSHING

IN A "Memoire sur les aneurysmes,"[1] read before the Royal Academy of Sciences, Paris, in 1832, Gilbert Breschet wrote as follows with reference to the changes noted in the vessels proximal to an arteriovenous fistula:

"It is necessary that the wound of the artery should be of a certain size, and that it be made in a direction to bring about the production of an opening constantly wide open and in direct contact with that of the vein. The works of Jones, of J. Bell, of Beclard, of Guthrie, and our own experiences in wounds of the vascular system, demonstrate that the kind of instrument that wounds the artery, the direction and extent of the wound made in the walls of this vessel, are not indifferent circumstances in connection with the results of the traumatic lesion, for according as the wound of the artery is parallel or perpendicular to the axis of the vessel, and especially according as the transverse wound is of greater or less extent, there results from it a simple fissure or a rounded opening constantly gaping, and consequently this wound will become cicatrized or will give place to a varicose aneurism, and the latter will permit, more or less freely, *the entrance of the venous blood into the artery.*[2] The dilatation of the brachial artery above the wound of this vessel and its flexuosity was observed by W. Hunter and considered by him as an effect of the afflux of a larger quantity of blood into this artery because part of the blood which it contained was introduced into the vein. This does not appear to us to be sufficient reason nor in harmony with physical laws. These changes in the condition of the vessel appear to us rather *to result from the passage of a small quantity of black blood into the artery by the traumatic opening,*[2] the dilatation and increase in length of the artery not being limited precisely to that part of the canal situated below the wound."

Breschet's reasons for the changes in the blood-vessels (as indicated in the italicized lines) seem rather fanciful to us to-day, but there is both clinical and experimental evidence that he was correct in his assumption that "the direction and extent of the wound made in the walls of the artery are not indifferent circumstances in connection with the results of the traumatic lesion."

Experimentally, the intimate relationship between circulatory changes and

[1] Memoire sur les aneurysmes, Gilbert Breschet, Mem. de l'Acad. roy. de med. Paris, 1833, vol. iii, p. 101.

[2] The italics are the author's.

arteriovenous fistula has been definitely established.[3] Hearts which have dilated in response to the formation of a fistula have again subsided following the elimination of the fistula. Vessels proximal to the fistula have enlarged following its formation and contracted after its excision or closure. Though contrary to the view expressed by Lewis and Drury,[4] if I understand them correctly, there is also experimental evidence to show that the hydraulic principles normally concerned in the maintenance of blood-pressure in the circulatory system also function in the presence of a fistula, and that the cardiac enlargement and dilatation of the proximal vessels can be explained on purely mechanical and physical grounds. The area of lowered resistance introduced into the circulatory system by the fistula results in the establishment of two routes for the passage of blood (Fig. 1): (1) through the normal capillary bed back to the heart, and (2) through the fistula back to the heart. It is in accordance with physical laws that a greater volume of blood will be directed toward the fistula with its minimal resistance than toward the capillary bed, and it is this greater column of blood flowing toward and through the fistula that produces the dilatation of the vessels leading to and from the fistula. The greater volume of blood flowing through the fistula per unit of time must necessarily pass through the heart, and just as the vessels place themselves in harmony with the volume of blood passing through them, so the heart will dilate to accommodate the increased flow per unit of time through its chambers.

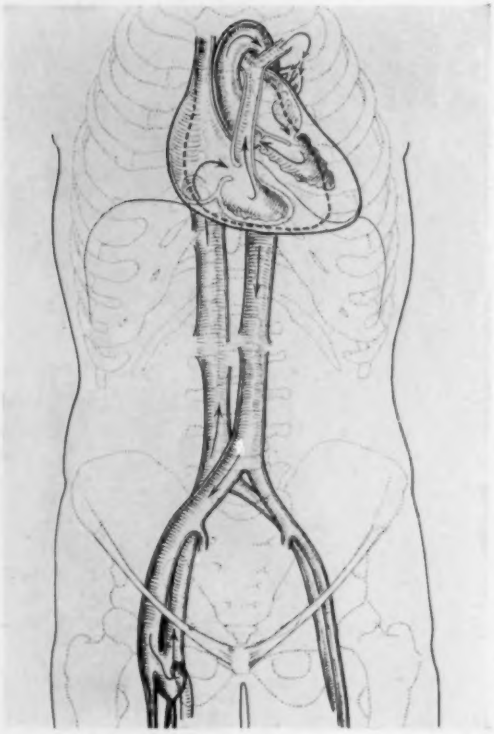

FIG. 1.—Schema of circulation in a case of a right femoral fistula (Charles Mundi): Dilatation of that portion of circulatory system represented by heart-artery-fistula vein. Dotted line shows cardiac area two months after excision of fistula.

Obviously, the amount of blood which will be short-circuited through the fistula back to the heart depends upon the size of the opening and upon the unobstructed return flow to the heart. Experimentally, small fistulæ produced very minor changes, and tended to heal spontaneously, whereas large fistulæ resulted invariably in a dilatation of the vessels and heart due to the

[3] Experimental Studies in Arteriovenous Fistula by Emile Holman, Archives of Surgery, Nov., 1924, vol. ix, pp 822–879.

[4] Observations Relating to Arteriovenous Aneurism, T. Lewis and A. N. Drury, "Heart," vol. x, No. 4, Oct., 1923, pp. 301–389.

increased volume flow through them. This dilatation is progressive and will continue until the resistance offered by the fistula, plus the resistance to any further dilatation of the vessel leading to it, equals the resistance which exists in the capillary bed elsewhere. When this equalization of resistances in the two systems is reached, there will be no further increase in the volume of blood flowing toward and through the fistula, and consequently that part of the circulatory system through which this short-circuited blood must pass will undergo no further dilatation. Numerous cases are recorded in the literature which have apparently reached an equilibrium, the one of longest standing being a temporal fistula of 36 years' duration.[5]

It was shown experimentally that this increasing volume flow through the fistula is accompanied by an increase in total blood volume as one of the compensating adjustments for the short-circuited blood flow. This is a necessary adjustment if general blood-pressure is to be maintained at a level compatible with life in the face of the marked fall in peripheral resistance introduced by the fistula.

As clinical evidence of the intimate relationship between the size of the fistula and the development of circulatory changes, the following case is presented:

Charles Mundi, aged forty-two, a most coöperative patient, first entered Doctor Cushing's service at the Peter Bent Brigham Hospital in November, 1921, Surgical No. 15706, when the diagnosis of a spastic paraplegia from spinal sclerosis was made, associated with an arteriovenous aneurism of the right femoral vessels. He was discharged untreated. He reëntered the hospital on September 24, 1923, at Doctor Cushing's request in order that we might observe the progress of his malady. The question had arisen as to what association, if any, existed between the fistula and the spinal sclerosis, and on the assumption that such an interrelationship might possibly exist, he was again studied with reference to the advisability of eliminating the fistula by operation.

Clinical History.—The following relevant facts were obtained as to the development of a slowly progressive general weakness which apparently, but not certainly, followed in the wake of the arteriovenous fistula of the femoral vessels.

At the age of twelve he had typhoid fever, accompanied by a temporary swelling of the right leg. When a student at college at the age of sixteen, he was one day cleaning a rifle, with the barrel resting in his right groin. The rifle was accidentally discharged, the bullet passing through his upper thigh and emerging from the buttock. There was momentary profuse bleeding, controlled, however, with no great difficulty by local pressure. The wound healed per primam, but he was compelled to remain in bed for almost two months because of extreme weakness. During the first few days his right leg swelled to enormous proportions. At one time his right ankle measured 17 inches in circumference. This swelling then gradually receded and had practically subsided when he returned to school two months after the accident. This great swelling below an arteriovenous aneurism has been an invariable occurrence, experimentally, following the formation of large femoral and iliac fistulæ. The gradual subsidence within 8 to 10 weeks was also noted in our experimental animals. He does not remember the time of onset of the thrill, but it was detected neither by the doctor nor by himself while he lay in bed. He believes it came on within several months after the accident, but as it seemed to give him no trouble he paid no further attention to it.

[5] C. H. Moore: An Account of a Case of Arteriovenous Aneurism of the Temporal Vessels. Med. Chir. Jr., London, 1858, vol. xli, p. 1.

Several years later, from 1907 to 1911, he served as a deputy sheriff in the Canadian Northwest, most of his time being spent on horseback. While in Alberta he sustained gunshot wounds of the left arm and later of the right arm, neither injury giving him any permanent trouble. Ere long he began to notice a slight weakness of the right leg, which hindered him in mounting the saddle. This weakness finally forced him to quit his post in Canada, and he returned to Boston, where he worked as a clerk in a store, still actively on his feet. His general health began to fail, however, and hoping to regain his strength in the open air, he bought a farm. The change proved of little value, his disability progressed, and there developed sudden attacks—unaccompanied by loss of consciousness—in which both legs seemed to give way, causing him to fall to his knees. A few minutes of rest would enable him to go on.

FIG. 2.—Photograph of patient before operation to show (black lines) the comparative sizes of the two femoral vessels just below Poupart's ligament; also the large vein just above the pubis, and the differences in the size of the two legs, particularly below the knee.

Since 1914, there has been a slowly progressive increase in his malady. The general weakness progressed, until it involved both legs and both arms, and on admission he could barely get about with the use of a cane. His right leg became quite useless, subject to spasmodic twitching and contractions at the knee and hip which were entirely uncontrollable. There had also developed in the past few years an annoying inability to retain his urine, accompanied by a marked frequency.

Physical Examination.—On physical examination the patient presented two presumably unrelated maladies, one of the nervous system, the other of the cardiovascular system. Briefly, the important neurological observations were a markedly impaired general muscular strength, evident atrophy of the interossei muscles, and of the thenar and hypothenar eminences on both sides, a marked spasticity of the lower extremities most marked on the right, with a bilateral inexhaustible ankle clonus, hyperactive knee kicks, and a positive Babinski response on the right. There was noted on one occasion fibrillary twitching of the pectoral muscles, and frequent spasmodic uncontrolled movements of the right leg were constantly present, these movements consisting of flexion of 30° at the hip and knee, and dorsal flexion of the foot and big toe. There were no sensory changes, and no ataxia, nor nystagmus.

Cardiovascular System.—The fistula and its dependent vascular phenomena presented the main points of interest. In the right groin about 2½ cm. below the middle of Poupart's ligament was a short scar marking the site of the wound of entrance. There was an evident fulness in Scarpa's triangle, and on palpation over this area the

characteristic thrill of an arteriovenous fistula, continuous throughout the cardiac cycle, but intensified during systole could be felt. This thrill was diffusely palpable over an area just larger than the flat of one's hand, its point of greatest intensity being 2 cm. below and 2 cm. medial to the midpoint of Poupart's ligament. On auscultation over the point of greatest thrill a deafening bruit was heard, which could be followed along the proximal vessels to a point above the umbilicus and along the distal vessels to the ankle. The thrill and bruit disappeared completely on digital compression over the point of greatest intensity, which presumably obliterated the communication between the two vessels.

On palpation the iliac and femoral vessels felt greatly enlarged up to the point of greatest thrill, where there was a sudden reduction in the size and "lift" of the artery. The femoral artery just below Poupart's ligament felt about 2 cm. in diameter on the right and hardly half that size on the left (Fig. 2). Blood-pressure readings in the left leg were recorded as 140/58, in the right leg 124/50. Blood-pressure in the left arm varied from 110/56 to 120/58. The pulsation in the popliteal, posterior tibial, and dorsalis pedis arteries could just be felt on the right, though readily palpable on the left. There was a markedly prominent vein in the abdominal wall just above the pubis. With the right leg elevated at right angles to the body and the artery in the groin closed by compression, the toes retained their normal pink color after 5 or 6 minutes or as long as the femoral artery remained closed, indicating an excellent collateral circulation.

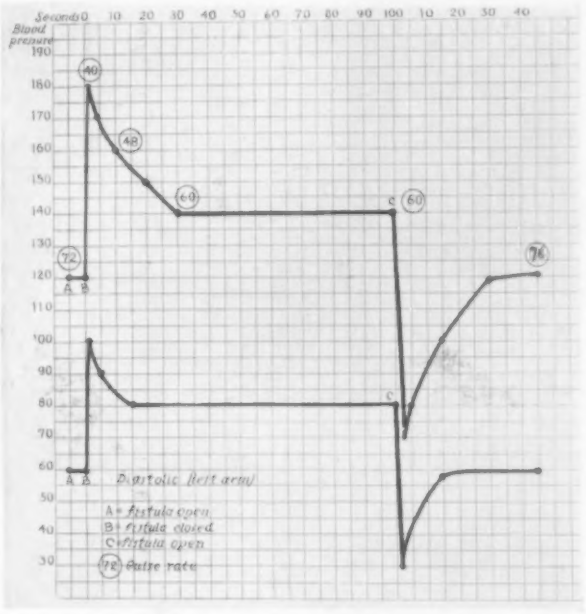

FIG. 3.—Fluctuations in blood-pressure (left arm) on opening and closing femoral fistula, accompanied by variations in pulse rate.

On palpation the greatly enlarged proximal artery could be followed to the bifurcation of the aorta, where the right common iliac seemed at least twice as large as the left. An apparently enlarged abdominal aorta could be easily palpated. The liver descended 5 cm. below the costal margin on inspiration, but did not pulsate.

The cardiac impulse was quite prominent in the fifth interspace, 2 cm. outside the nipple line. At the level of the fourth rib, the heart measured 11.5 cm. by 3½ cm. The cardiac area had apparently increased about three centimetres in width since the examination on his first admission two years previously. There was no shock nor thrill present over the cardiac area, but on auscultation a distinct systolic murmur was heard over the entire precordium.

Laboratory examinations revealed a negative Wassermann reaction in blood and spinal fluid. Red blood-cells, 4,750,000; hæmoglobin, 110 per cent. (Sahli); white blood cells, 9000; urine negative.

A variety of special tests were made:

(A) *Effects on Circulation Produced by Closing the Fistula.*—On closing and opening the fistula, startling changes in blood-pressure and pulse occurred (Fig. 3). These fluctuations in blood-pressure and pulse were recorded by means of a modified Erlanger

apparatus[6] employed in the experimental laboratory. The normal systolic pressure in the left arm was 116 to 120. Closing the fistula caused an immediate increase in systolic pressure to 180 for two beats only, after which it fell rapidly and steadily to 140, where it remained as long as the fistula was closed (Fig. 4). Changes in diastolic pressure

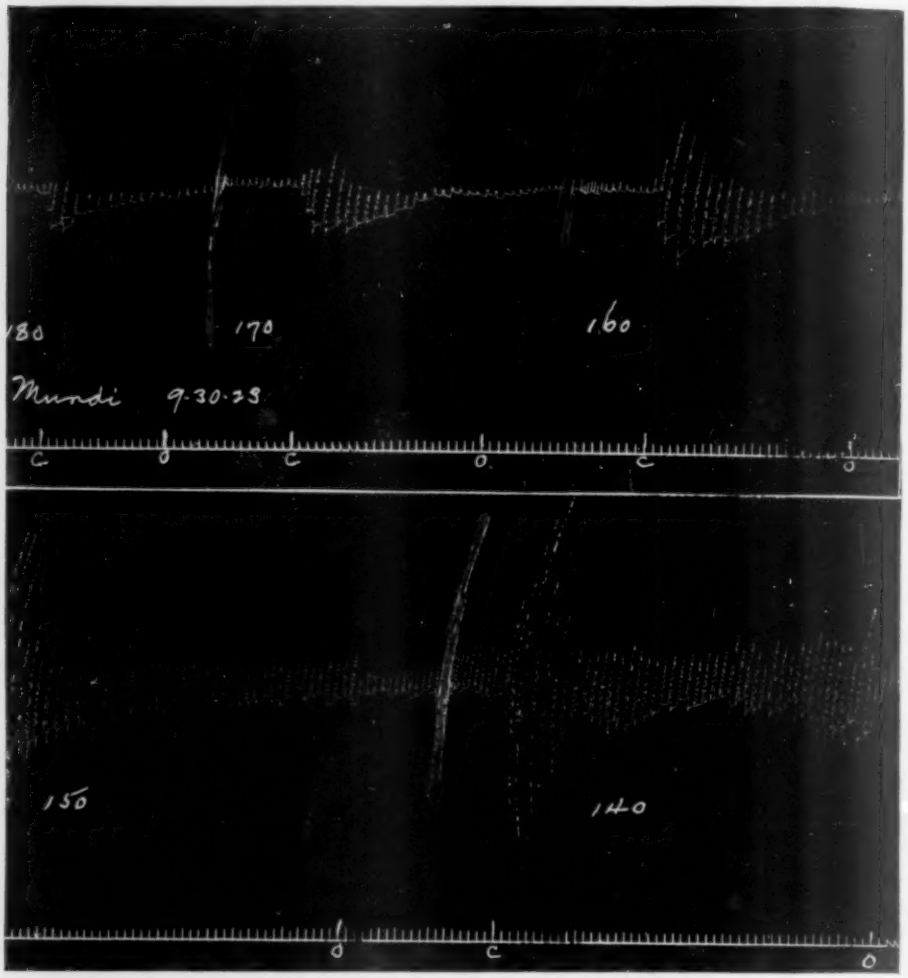

FIG. 4.—Kymographic records obtained by means of a modified Erlanger blood-pressure apparatus. With a pressure registration in the apparatus of 180 mm. Hg., 2 systolic beats were recorded on closing the fistula, 5 beats were recorded through a pressure of 170, 11 beats through a pressure of 160, 20 beats through a pressure of 150, and all the subsequent beats were recorded through a pressure of 140, indicating a systolic blood-pressure of 140 as long as the fistula was closed. C—Fistula closed. O—Fistula opened.

exactly paralleled the systolic fluctuations. Accompanying the increased blood-pressure, there occurred on closing the fistula a remarkable retardation in pulse rate from 80 to 40 beats with a gradual recovery to 60, where it remained as long as the fistula was closed.

As indicated in a previous article,[7] this rise in blood-pressure is attributed to forcing

[6] An Indirect Method for the Determination of Blood-pressure in the Unanæsthetized Dog, A. C. Kolls, Jour. of Pharm. and Exper. Therap., vol. xv, July, 1920.

[7] The Physiology of an Arteriovenous Fistula, Emile Holman, Arch. of Surg., July, 1923, vol. vii, pp. 64–82.

into the general capillary system the large volume of blood previously short-circuited through the fistula, the reduction in pulse rate being a compensatory adjustment for this increased pressure.

(B) *Atropine Eliminates the Retardation in Pulse But Not the Rise in Pressure on*

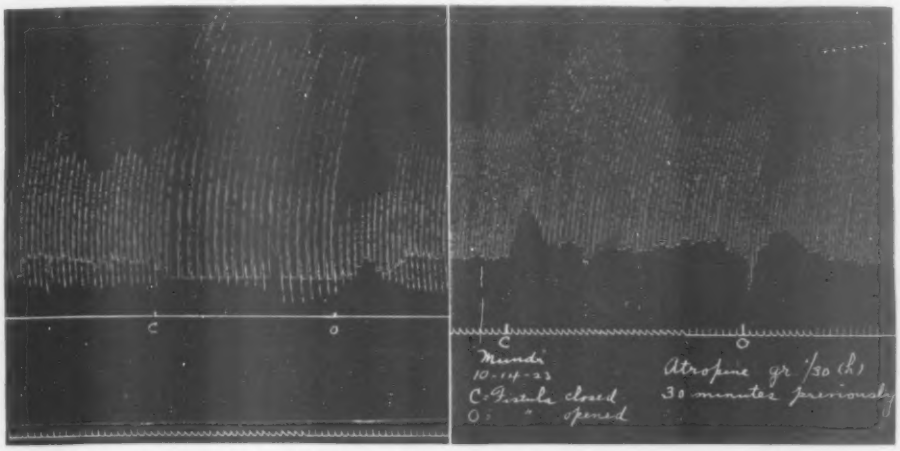

FIG. 5.—(a) Effect of closing fistula by digital compression: Increase in general blood-pressure with retardation of pulse. (b) Effect of closing fistula 30 minutes after the administration of atropine gr. 1/30: A rise in pressure but no retardation in pulse. C—Fistula closed. O—Fistula opened.

Closing the Fistula.—That the retardation in pulse is dependent almost entirely upon vagal stimuli was apparent from the following experiment: Closure of the fistula resulted as usual in an increase in pressure and a fall in pulse rate (Fig. 5a). Atropine, gr. 1/30,

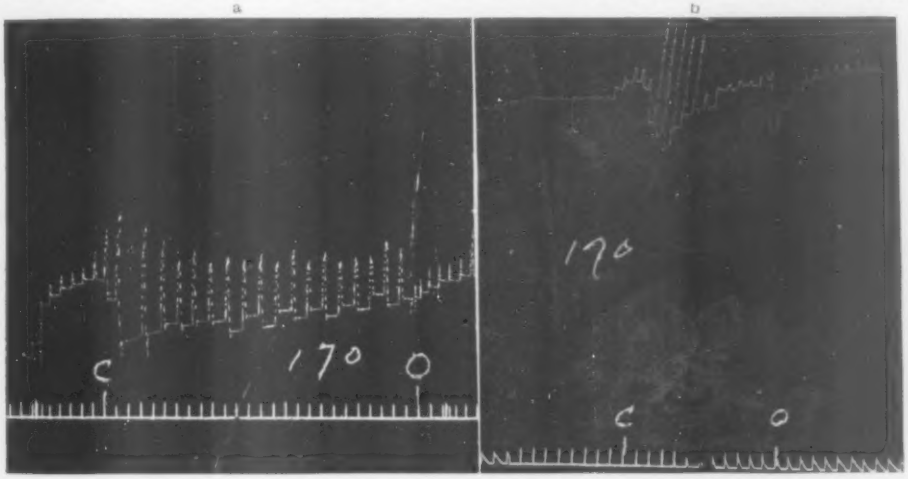

FIG. 6.—(a) With pressure in the Erlanger apparatus at 170 mm. Hg., closing the fistula resulted in recording several systolic beats, with marked retardation in pulse. (b) Following the administration of atropine, several systolic beats were recorded at 170 mm. Hg., on closing the fistula, but without retardation in pulse.

was administered subcutaneously, and thirty minutes later the fistula was closed without any effect on pulse rate (Fig. 5b). That an increase in pressure occurred was demonstrated by a kymographic record obtained with the pressure in the Erlanger system at 170 mm. Hg. On closing the fistula systolic beats were recorded coming through at this level, without a slowing of the pulse (Fig. 6b). The record normally obtained on closing the fistula showed the systolic beats coming through a pressure of 170, accompanied by

a marked retardation in pulse (Fig. 6a). The explanation of the retarded pulse is no doubt dependent upon a distention of the aorta by the volume of blood previously short-circuited through the fistula. This distention stimulates the depressor vagus fibres, and slowing of the heart is the inevitable result.

(C) *Röntgenological Studies of the Heart on the Effect of Closing the Fistula.*—Observations were made on the changes in cardiac shadows dependent upon conditions

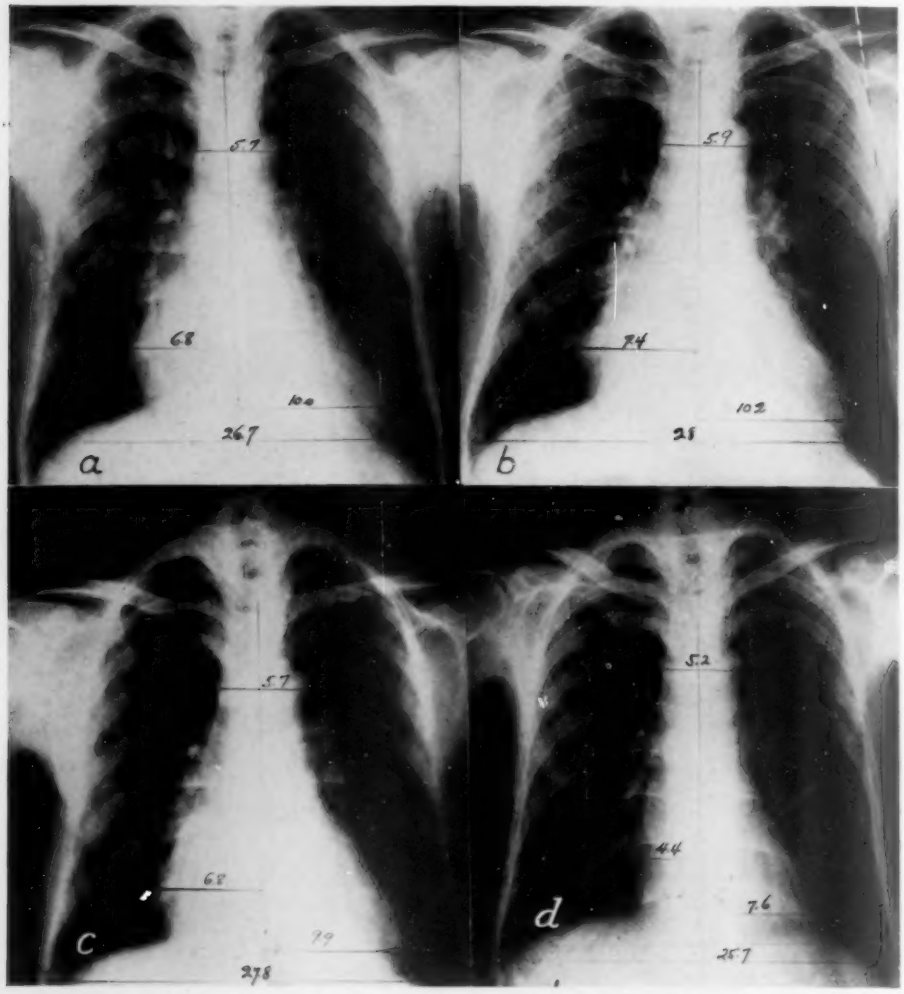

FIG. 7.—Teleoröntgenograms illustrating: (a) (Fistula opened:) Immense dilatation of heart due to presence of arteriovenous fistula. (b) (Fistula closed:) Marked increase in cardiac and aortic shadows *immediately* after closure of femoral fistula by digital compression. (c) (Fistula still closed:) Prompt subsidence of this increased dilatation within 20 seconds after closure. (d) Marked reduction in cardiac area two months after excision of fistula.

at the fistula. The total transverse diameter of the heart before compression of the fistula was 16.8 cm. (Fig. 7). Immediately after compression it was definitely more dilated, measuring 17.6 cm. Within 20 seconds this increased dilatation had subsided, and the heart again showed a diameter of 16.7 cm., the fistula having been closing during this entire time. This illustrated conclusively that there was an immediate dilatation of the heart and also of the aorta by the sudden transfer into the general and capillary circulation of the volume of blood previously coursing through the fistula. Compensatory

adjustments came into play immediately, such as the peripheral dilatation of the capillary and arteriolar beds, and the cardiac dilatation again subsided, even though the fistula remained closed.

(D) *Electrocardiograms to Illustrate Effect of Closing the Fistula.*—Electrocardiographic[8] studies (Fig. 8), revealed a normal mechanism. It is evident from a study of the various records obtained (Fig. 9) that the first effect of closing the fistula was an immediate rise in blood-pressure. This increased pressure was then *followed* by a retardation in pulse rate which manifested itself only on the second or third cardiac contraction after closure of the fistula. This is a small but important corroboration of the hypothesis that the physiological mechanism for the maintenance of a uniform blood-pressure is

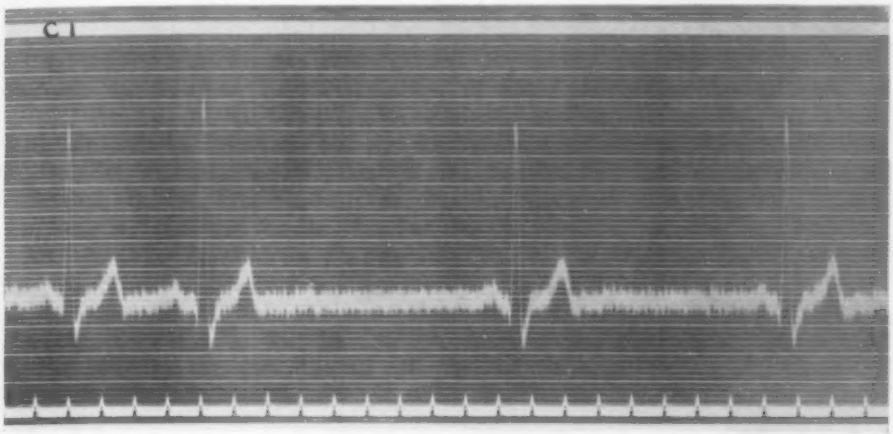

FIG. 8.—Normal electrocardiogram illustrating marked increase in pulse interval on closing fistula by digital compression. Lead I. C—Fistula closed.

responsible for the circulatory phenomena associated with arteriovenous aneurism. The retardation in pulse *follows* the increased pressure and is a compensatory mechanism to counterbalance this increased blood-pressure produced by closure of the fistula.

(E) *Effect of Closing the Fistula on the Systolic Heart Murmur.*—The systolic murmur heard over the whole precordium seemed definitely more pronounced with the fistula open than with the fistula closed. This was brought out much more clearly by the following method, which also revealed another important fact: Ten or twelve deep inspirations resulted in a superaeration of the lungs and in an acapnia. After complete expiration, which collapsed the lung entirely over the cardiac area, the patient was told to hold his breath as long as he could, and the various valve areas were auscultated in rapid succession. The superaeration of the lungs enabled the patient to hold his breath one or two minutes, allowing one to auscultate each valve area in turn and to make accurate comparisons among them. Before this method was attempted it was impossible for me to say definitely which valve was responsible for the systolic murmur, but during the prolonged acapnia it was evident that the murmur originated in the pulmonic area and not in the mitral or aortic areas. This method of studying heart murmurs may possibly be of value in determining their exact character in other valvular lesions.

(F) *Effect of Closing the Fistula on Vital Capacity.*—Closing and opening the fistula seemed to have some influence on the vital capacity as the following observations indicate:

Fistula open: Vital capacity 2.17 litres.
Fistula closed: Vital capacity 2.47; 2.37; 2.60; 2.35 litres.
Fistula opened: Vital capacity 2.2; 2.15; 2.35 litres.
Fistula closed: Vital capacity 2.4; 2.47; 2.57; 2.4 litres.
Fistula opened: Vital capacity 2.2; 2.17; 2.3; 2.2 litres.

[8] I am indebted to Dr. A. Wilmaers, of Brussels, Belgium, for these studies.

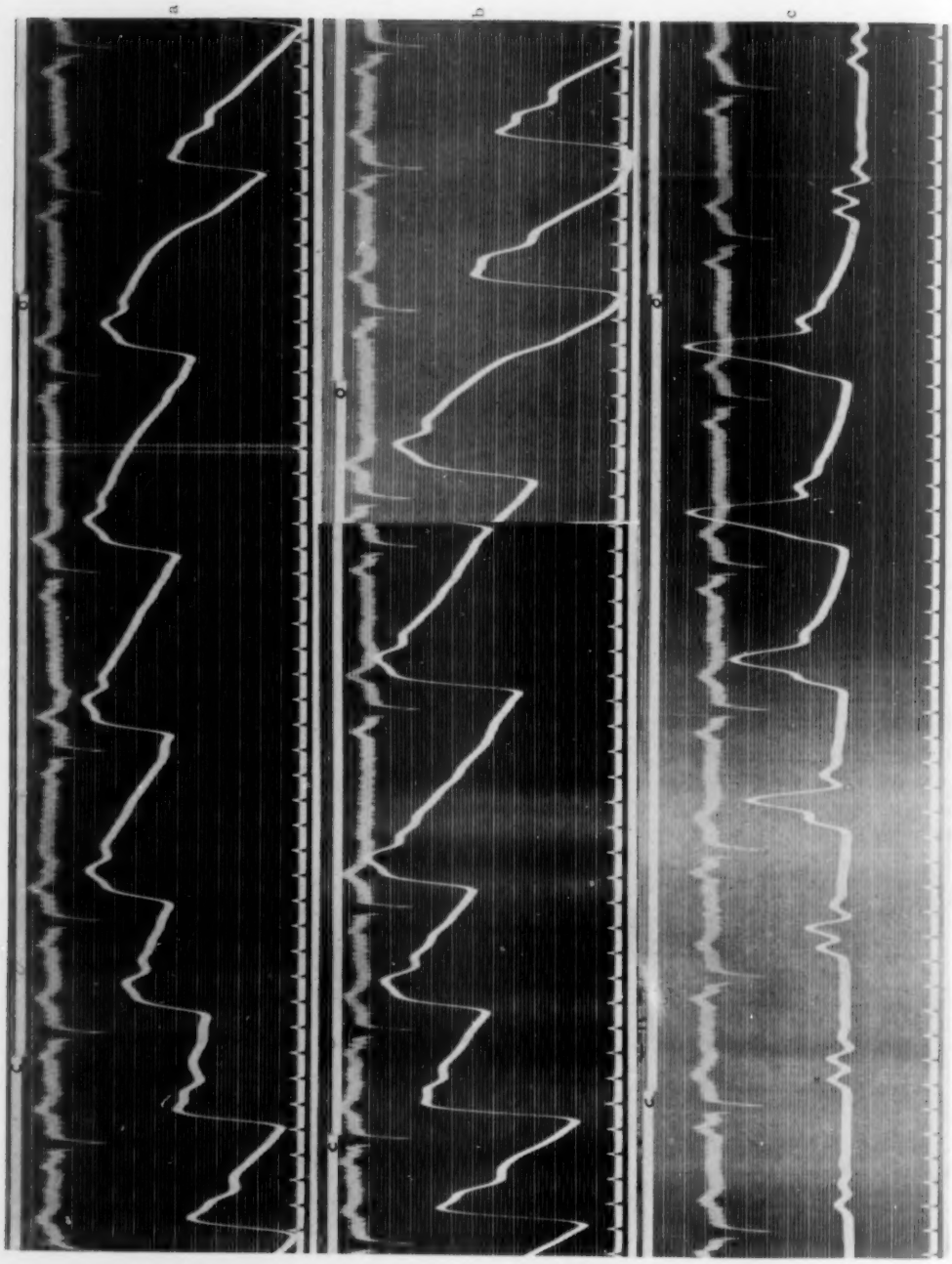

FIG. 9.—Electrocardiograms and sphygmographic records of cardiac contractions with fistula opened and fistula closed. (a) Pressure in system 55 mm. Hg. (b) Pressure in system 70 mm. Hg. (c) Pressure in system 140 mm. Hg. Records show that the *first* effect of closing the fistula is an increase in blood-pressure and the *second* effect a retardation in pulse. Readings obtained with a Pachon oscillometer. C, Fistula closed. O, Fistula opened.

These readings suggest an increased vital capacity when the fistula was eliminated from the circulation. Post-operative readings have failed to confirm this, and so we must defer any conclusions from the above evidence.

Operation.—The marked increase in blood-pressure with the fistula closed and the known results of previous operations in reducing the greatly dilated hearts, resulting from arteriovenous aneurism, prompted us to undertake the elimination of the fistula by operation, partly in the hope that an improved circulation might have some influence in checking the progress of the spinal sclerosis.

On October 15, 1923, the patient was operated upon and the following conditions disclosed (Fig. 10). The fistula lay so high in the groin that a tourniquet was out of the question. The vessels were exposed through a T-incision, dividing Poupart's ligament. Careful dissection revealed huge femoral and external iliac vessels. The external iliac artery was isolated and controlled about 3 cm. above the fistula by a broad tape. The dilated proximal vein was also isolated and controlled in the same manner. There was a large ampullar dilatation of the vein distal to the fistula, which ended abruptly at a point 2 cm. beyond the fistula in a thickened fibrous vein wall, the result probably of the old post-typhoid thrombophlebitis. All cardinal vessels having been similarly controlled with broad tapes, the artery and vein were separated. The large annular fistulous communication was fully 1.8 cm. in diameter. Numerous calcareous deposits were present in the arterial wall, preventing a dependable closure of the arterial opening. It was felt that the mere closure of the artery in the presence of these calcareous deposits might easily lead to a subsequent saccular aneurism at the point of closure through a weakened arterial wall. Accordingly the vessels were all permanently ligated, the fistula excised, and the wound closed without drainage. The circulation of the foot was observed at various intervals during the operation and found to be unimpaired at any time. Immediately following the excision of the fistula the stumps of the arteries distal to the fistula were beating quite as vigorously as the proximal arterial stumps, indicating a good circulation in the lower leg.

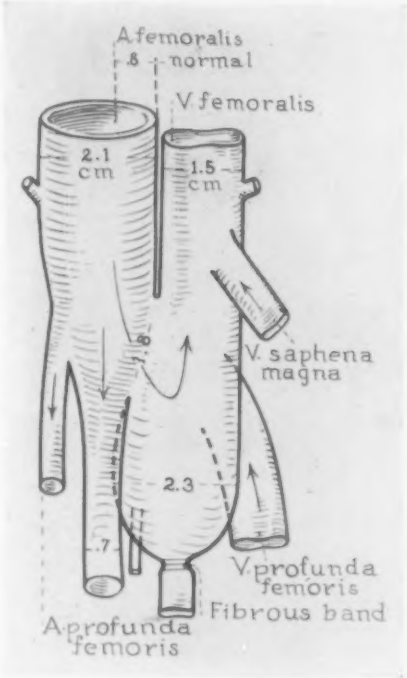

FIG. 10.—Conditions found at operation when fistula was excised.

Several interesting points were noted in the course of the operation. During the exposure of the vessels the pulse varied from 108 to 112. Closure of the artery proximal to the fistula resulted in an immediate reduction in pulse rate to 80 with obliteration of the continuous thrill. Simple closure of the vein proximal to the fistula, *with the artery open*, also obliterated the thrill and caused the pulse to drop to 84. This was in accord with our experimental observations, and demonstrated that the free return flow to the heart is of prime importance in the development of the circulatory phenomena resulting from the fistula. Closure of the distal artery and vein had no effect upon the pulse. The permanent ligation of the artery resulted in a retardation of pulse to 84, which persisted during the remainder of the operation. At the conclusion of the four-hour procedure the pulse was only 80, and two hours later it had dropped to 60. This behavior of the heart rate is explained on the basis of an "auto-transfusion." By the excision of

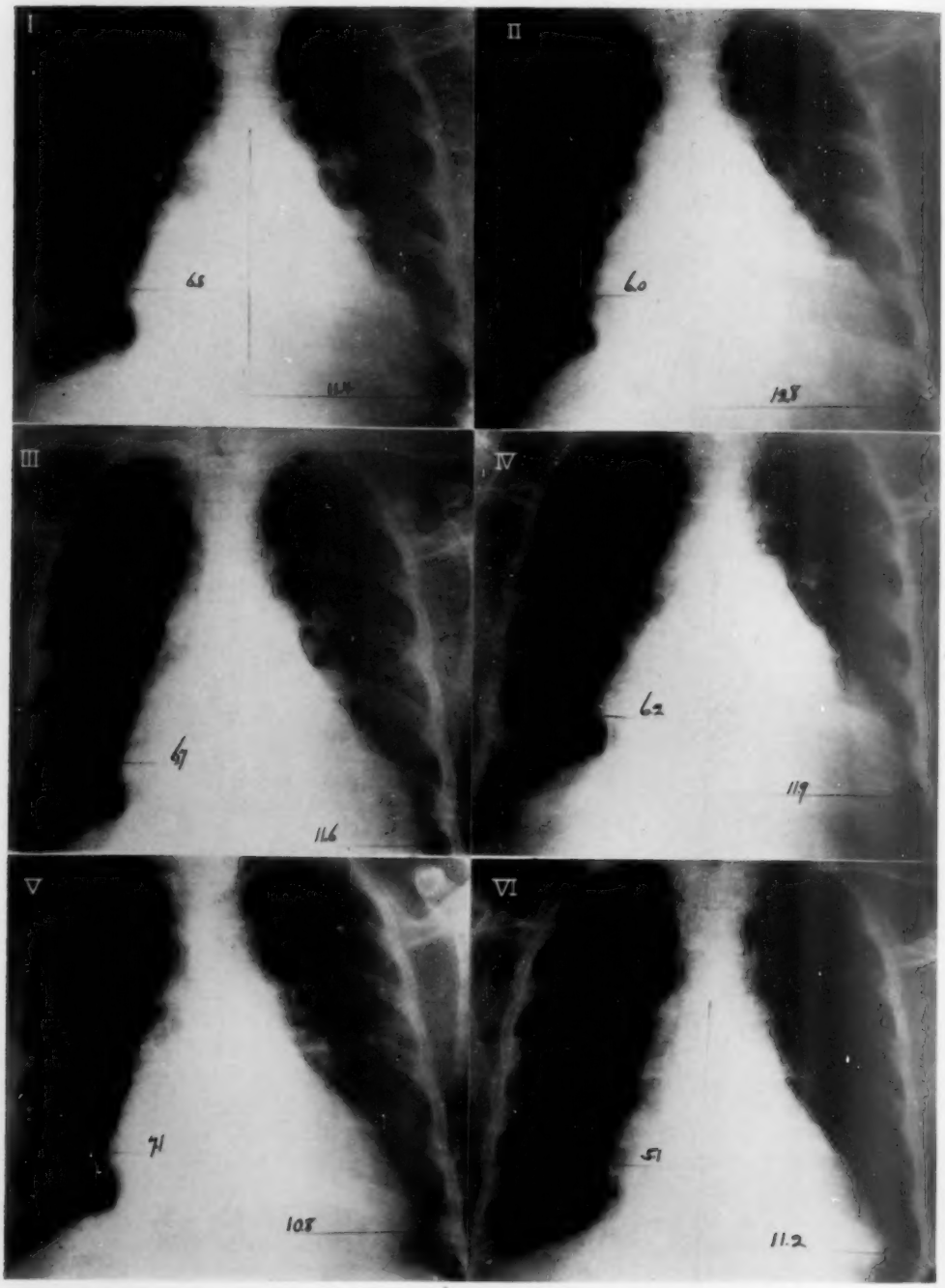

FIG. 11.—Röntgenograms of heart: (I) Just before operation, October 15, cardiac area 18.2 cm. wide. (II) Immediately after operation showing a definite dilatation, cardiac area 18.8 cm. wide. (III) Five hours after operation, October 15, cardiac area 18.3 cm. wide. (IV) Second day after operation, October 16, cardiac area 18.1 cm. wide. (V) Third day after operation, October 17, cardiac area 17.9 cm. wide. (VI) Sixth day after operation, October 20, cardiac area 16.3 cm. wide.

the fistula, the heart and vessels of the general circulatory system became distended by the volume of blood previously short-circuited through the fistula.

Repeated X-ray studies of the heart gave corroborative evidence of this assumption.[9] Immediately after operation, the cardiac shadow was definitely increased in area as compared to the pre-operative size (Fig. 11). Blood-pressure readings at this moment were only 98/68 with a pulse of 80. This low pressure was noted immediately after permanent ligation of the external iliac artery proximal to the fistula, and is probably explicable on the basis of a weakened heart muscle overdistended by the volume of blood previously short-circuited through the fistula. With a rapid reduction in blood volume, this acutely dilated heart subsided and by 7 o'clock, six hours after the conclusion of the operation, general blood-pressure had recovered to 122/78 with a pulse of 54, and the cardiac area

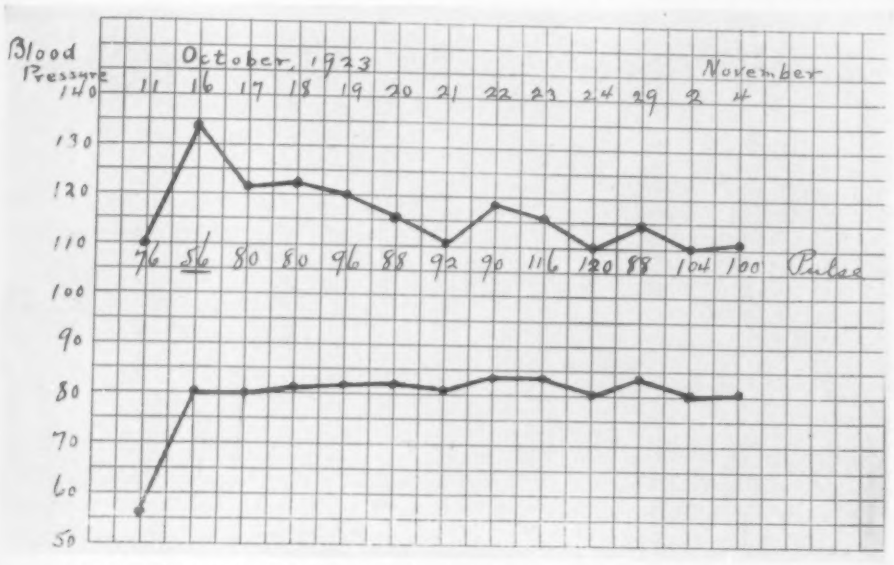

FIG. 12.—Behavior of blood-pressure and pulse following excision of the fistula on October 15. Note: (a) Temporary elevation of systolic pressure with marked retardation in pulse. (b) Permanent elevation of diastolic pressure. (c) Reacceleration of pulse on third day.

had subsided to its pre-operative size as shown in Fig. 11 (III). The rapid diminution in cardiac area during the first five days after operation is evident from an examination of the successive X-ray photographs taken during this period (Fig. 11). This diminishing cardiac area was demonstrable not only by X-ray, but also by physical examination. Within five days the apical beat had receded to the nipple line, 10 cm. from the midsternum, and within 15 days it was located 1 cm. medial to the nipple line. The marked systolic murmur present before operation was practically inaudible seven days after operation, a fact which identifies it rather intimately with the dilatation of the heart.

The behavior of blood-pressure after operation is illustrated in Fig. 12. On the day following operation a blood-pressure of 134/80 and a pulse of 56 were recorded. On the next day blood-pressure had fallen to 122/80 with a pulse of 80. The systolic pressure gradually fell to the pre-operative level of 110–120, but the diastolic level remained permanently elevated to 80, as compared to a pre-operative level of 56–58. This behavior of blood-pressure after operation was noted in my previous case of arteriovenous fistula, and has been reproduced experimentally in dogs. The gradual adjustment in systolic pressure is attributed to a gradual diminution in total blood volume, which no doubt had

[9] I am indebted to Dr. Burgess Gordon, resident physician, for the post-operative X-ray examinations. A specially constructed bed enables him to make photographs with a portable apparatus without disturbing the patient.

increased in the presence of this large fistula, just as it does experimentally in the presence of large fistulæ.

Before operation, on one occasion only, the patient had exhibited the curious phenomenon of a "pulsus alternans" during the period in which the fistula was closed by digital compression. After operation, again on one occasion only, the same phenomenon was observed, but it was present only for a short period, and disappeared within a few hours. This was of particular interest since pulsus alternans in cardiac lesions is generally considered to indicate an unfavorable outlook.

A gradual and progressive improvement in the circulatory system was noted after operation, as judged mainly by the marked diminution in cardiac area and the elevated diastolic pressure (Figs. 7d and 12). A definite diminution in the size of the common iliac artery as determined by palpation was also noted. The patient's spinal symptoms were in no wise benefited by the operation and the evidence of sclerosis has continued to progress. Though it is tempting to speculate upon the possible relationship of the two lesions, they were probably independent of one another.

The case is of particular interest, first, because it corroborated many of our experimental observations, and secondly, because a marked cardiac enlargement and proximal dilatation of the vessels occurred in the presence of a large femoral fistula 1.8 cm. in diameter, a dilatation which almost entirely disappeared following the elimination of the fistula.

Several years previous to his death, the late Professor Halsted gathered from the literature of the world all the cases of arteriovenous fistula theretofore described, and lengthy abstracts were made available for an analytical study by Callander.[10] This analysis did not include observations as to the size of the fistulous opening, and as this has proven to be of first importance in the subsequent development of visceral changes, it was considered advisable to review the abstracts made by Doctor Halsted with this point in mind. Important and confirmatory data was obtained, but more frequently than not the various authors' descriptions were necessarily meagre on the question of the size of the fistula, and even where it might easily have been included this important detail was lacking. A description of the size of the vessels and heart was also in many instances lacking or very inadequate. The following few examples, however, serve to illustrate the relationship between size of opening and the extent of the visceral changes.

C. B., No. 41803, J. H. H.[11] Femoral fistula (Hunter's canal) of many years' duration: "Artery proximal to the fistula was hugely dilated and tortuous. The heart was greatly enlarged. Fluoroscopic examination of the chest showed that the entire aorta was very much enlarged. Artery proximal to fistula 2 cm. wide, distal to fistula 1.2 cm. wide; vein 2.3 cm. wide proximally, 2 cm. wide distally. Fistula measured 2.7 cm. by 1.3 cm."

M. H., No. 54125, J. H. H. Femoral fistula (Scarpa's triangle) of many years' duration, accompanied by a markedly dilated heart and by a considerable dilatation of the proximal vessels. The fistula was excised by Dr. M. R. Reid with rapid subsidence of the dilated heart. Size of fistulous opening: 2 cm. by 1 cm.

[10] Curle L. Callander: Study of Arteriovenous Fistula with an Analysis of 447 Cases, Johns Hopkins Hospital Reports, vol. xix, 1920.

[11] Cited in the Effect of Arteriovenous Aneurism on the Heart and Blood-vessels, by M. R. Reid, Johns Hopkins Bull., 1920, vol. xxxi, p. 43.

C. W.[12] Popliteal fistula of 24 years' duration resulting in a marked enlargement of the heart with extreme dilatation of the vessels proximal to the fistula. Size of fistula: 2.1 cm. in diameter.

Baker's Case:[13] Varicose aneurism at origin of profunda artery between femoral vessels of years' duration. "Heart greatly dilated in all its cavities. Walls hypertrophied. Ascending aorta dilated. Communicating aperture 1 inch in diameter."

Keyes' Case:[14] Varicose aneurism of lower popliteal vessels. Autopsy: "Sac size of goose's egg. Two large circular openings were found at the upper end of sac, the popliteal vein and artery, each opening *as a full circle* at about a middle point of the sac. The popliteal vein was dilated and thickened, the popliteal artery proximally was dilated."

Bank's Case:[15] Aneurismal varix of femoral vessels of six years' duration. "Artery above the point of communication was *somewhat* enlarged, below the communication the artery was contracted. Proximal vein was greatly enlarged. Diameter of the fistulous opening 3/16 of an inch, somewhat oval in shape."

Roberts' Case:[16] Femoral fistula (Hunter's canal) of six years' duration. Autopsy material (examined one year after preservation in alcohol) showed: "Common iliac artery on affected side twice as large as on sound side. Femoral vessels in collapsed state each measured about ½ inch in width. Below the orifice of communication the vein is practically the same size as it is above, but the artery below the fistula is only about half as large as above the fistula. The fistula, itself, was a circular opening about 3/8 of an inch in diameter with smooth edges."

Graves' Case:[17] Aneurismal varix of middle third of femoral vessels of six years' duration. Autopsy findings: "Femoral and iliac vessels, both artery and vein, dilated to a size larger than an adult thumb and were greatly thinned. Fistulous opening ⅓ to ¼ of an inch, directly between the vessels."

Da Costa's Case:[18] Aneurismal varix of popliteal vessels of three months' duration. Operation: "Vein and artery directly fused—no intervening sac. Artery distally small, proximally much dilated. Vein distally and proximally very much dilated and thickened." Operation was performed under a tourniquet, and the opening between the vessels was illustrated as being 1.5 cm. by 0.5 cm. in size.

Eisenbrey's Case:[19] Aneurismal varix of femoral vessels of 18 years' duration. Autopsy: "Hypertrophy and dilatation of the heart. Artery and vein dilated proximal to the fistula, each measuring 2.5 cm. in diameter. Communication between the vessels measures 0.7 cm. in diameter."

Hodge's Case:[20] Femoral fistula of 16 years' duration. Condition found at operation: "The two vessels, which were found to be enlarged, were joined together toward the

[12] Full Description in the Physiology of an Arteriovenous Fistula, by Emile Holman, Arch. of Surg., July, 1923, pp. 64–82.

[13] Baker, A.: Varicose Aneurism of Profunda Femoris at its Origin. Prov. Med. and Surg. J., 1850, vol. xiv, p. 158.

[14] Keyes, E. L.: Arteriovenous Aneurism, Virginia Med. Mon., 1881–2, vol. viii, pp. 644–659.

[15] Banks, C. E.: Case of Aneurismal Varix Involving the External Iliac and Femoral Vessels. Rep. U. S. Marine Hosp. Service, 1882, p. 150.

[16] Roberts, John B.: A Case of Varicose Aneurism of the Thigh. ANNALS OF SURGERY, 1895, vol. xxii, p. 372.

[17] Graves, S. C.: Arteriovenous Aneurism of the Femoral Vessels. Am. Med., 1903, vol. v, p. 962.

[18] Da Costa, J. C.: Operation for Aneurismal Varix of the Popliteal Vessels. ANNALS OF SURGERY, 1912, vol. lv, p. 593.

[19] Eisenbrey, A. B.: Arteriovenous Aneurism of the Superficial Femoral Vessels. Jour. A. M. A., 1913, vol. lxi, p. 2155.

[20] Hodge, E. B., and Sweet, J. E.: Arteriovenous Aneurism of the Femoral Artery and Vein. Trans. Phil. Acad. Surg., 1915, vol. xvii, p. 209.

end of the enlargement by a channel about 1½ inches in length, the actual communication appearing to be ¼ of an inch wide."

Guinard's Case:[21] Fistula of middle third of femoral vessels of two years' and three months' duration. No dilatation of artery or vein. Orifice of communication the "size of a lentil," *i.e.*, about 3 to 4 mm. in diameter.

Bergmann's Case:[22] Varicose aneurism of upper popliteal vessels of six months' duration. Operation: "Artery was *not* dilated, vein dilated to three times its usual size. Opening of artery into the vein was scarcely 3 mm. in diameter."

Wiesinger's Case:[23] Low popliteal fistula of 18 months' duration Vein enlarged, artery *not* enlarged. Opening in the artery 3 mm. long.

Cranwell's Case:[24] Fistula of popliteal vessels of six years' duration. Operation: "The artery was of *normal calibre*. The popliteal vein below the fistula was much thickened (arterialized). . . . It was a true arteriovenous fistula, the canal being about 3 or 4 mm. broad by the same measurement in length."

It is apparent from a study of the last four cases that fistulæ only three to four millimetres in diameter do not cause any change in the proximal artery, although in three instances dilatation of the proximal vein was recorded. This has also been noted experimentally. It is evident also that duration of the fistula is a factor of minor importance in the development of these vessel changes. A large fistula of three months' duration (Da Costa) resulted in marked enlargement of the proximal vessels, whereas a small fistula of six years' duration (Cranwell) was accompanied by vessels of normal calibre. That large fistulæ invariably cause marked visceral changes is illustrated by the case of Charles Mundi and by eleven cases from the literature, in which the vessels were uniformly enlarged. The size of the heart was not always mentioned, but its enlargement has only been noted in the presence of fistulæ large enough to cause changes also in the proximal artery.

CONCLUSIONS

Clinically, the circulatory changes following the introduction of an arteriovenous fistula are dependent primarily upon the size of the fistula and upon an unobstructed return flow to the heart. Small fistulæ, however long they may have existed, do not cause changes in either vessels or heart. Slightly larger fistulæ may result in an enlargement of the proximal vein, but no visible change in the heart or proximal artery. Large fistulæ are inevitably accompanied by changes in both artery and vein and usually by a demonstrable enlargement of the heart. The extent of these changes is intimately dependent upon the size of the fistula.

These clinical observations are identical with those found in the experimental laboratory and are undoubtedly dependent entirely upon the amount of blood which finds its way through the fistula back to the heart.

[21] Guinard, A.: Bull. et Mem. Soc. de Chir. Par., 1902, vol. xxviii, p. 1125.

[22] Bergmann, E.: Zur Casuistrik des arteriell-venosen traumatischen Aneurysma. Arch. f. klin. chir., 1903, vol. lxix, p. 515.

[23] Fall von Aneurysma arterio-venosum, Wiesinger, D. Med. Woch., 1904, vol. xxx, s. 157.

[24] Contribution a l'etude due traitement de l'aneurisme arterioveineux. Cranwell, J., Rev. de Chir., 1906, vol. xxxiv, p. 817.

BONE TUMORS. MYXOMA*

SECOND PAPER WITH REPORT OF THREE NEW CASES

By Joseph Colt Bloodgood, M.D.
of Baltimore, Md.

The first complete report was published in the Annals of Surgery in December, 1920 (vol. lxxii, p. 713). The point emphasized in this report was that every myxoma of bone on record had recurred locally, and three of the cases reported died of metastasis. (A fourth subsequently died of metastasis to the lungs and was reported in the Annals of Surgery for January, 1923.)

Myxoma Other Than of Bone.—Apparently myxoma growing outside of bone is less malignant both as to local recurrence and internal metastasis. I have two cases of pure myxoma of the breast in which the tumors were excised without exploratory incision, one by Doctor Tyler, of Greenville, S. C., and the other by Doctors Thalheimer and Saltzstein of Columbia Hospital, Milwaukee, Wis. Both of these patients are well, one more than three, the other more than five years since operation. These myxomas somewhat resembled in the fresh the myxoma of bone, but they were firmer and when pressed did not exude a liquid tapioca-like material, or break up into particles like vesicles of a thin mucilage consistency. Under the microscope these myxomas show the lymphoid and stellate cells, but the stoma takes a little of the eosin staining, and there is evidently more fibrous tissue than in the myxoma of bone.

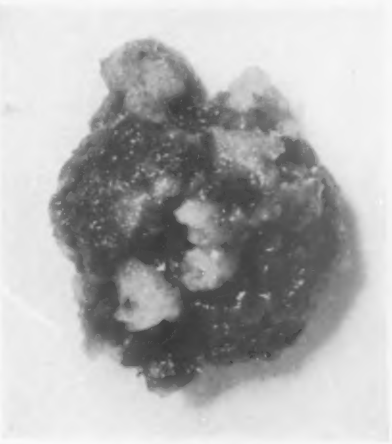

Fig. 1.—Case I. Pathol. No. 33423. Gross tissue floating in a hemorrhagic fluid. The white tapioca particles mixed with the tumor tissue stained dark by blood resemble the tissue in Fig. 11.

The connective-tissue part of the so-called intracanalicular myxoma of the breast differs from these two cases of pure myxoma in being less gelatinous, firmer, and under the microscope we rarely see the lymphoid or stellate cells. The characteristic feature of this adenoma of the breast is that the stroma takes the stain very lightly and resembles the stroma forming the envelope of the ducts and acini in the normal breast. These intracanalicular myxomas of the breast may recur when they are shelled out, but the recurrent tumors have always been benign, and the patients have never died of metastasis.

The myxomatous part of the so-called mixed tumor of the parotid and

* Read before the American Surgical Association at the Meeting in Baltimore, May, 1924.

neurofibroma is more like myxoma of bone, but in the gross rarely so gelatinous. But these two tumors do not show the same vitality in local recurrence when exploratory incision is made.

In the first paper on Myxoma and in a recent paper on Xanthoma † and in other contributions, I have drawn attention to the danger of local recurrence when tumors, even benign tumors, and even encapsulated benign tumors, are enucleated or "shelled out." The best example is the mixed tumor in the region of the salivary glands. The percentage of local recurrence here is larger. This can be explained by the fact that surgeons fear injury of the facial nerve, and for this reason practice enucleation or shelling out. Perhaps in the neurofibroma local recurrences take a second place, especially if the tumor is near a large nerve trunk. In the intracanalicular myxoma of the breast local recurrence is less frequently recorded, because most surgeons cut these tumors out, as taking away a little larger zone of breast tissue is not mutilating. However, in the myxoma of bone, there is additional danger if one even cuts into the tumor—the danger of transplantation of tumor cells into the open wound.

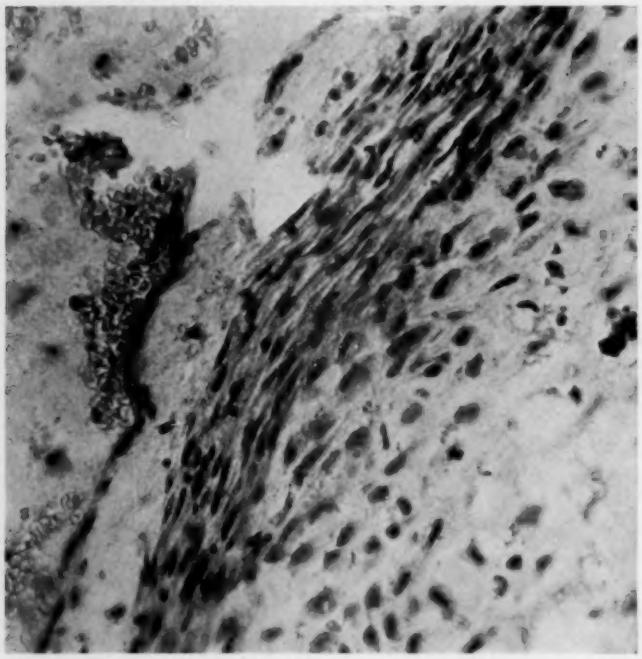

FIG. 2.—Case I. Pathol. No. 33423. From the first operation, curetting in June, 1922. The hemorrhagic part is separated from the myxomatous tumor by condensed cellular tissue, suggesting spindle-cell sarcoma.

Definite sarcoma not differing from any other type of sarcoma may develop in any of the connective-tissue tumors, apparently more frequently in a benign tumor containing myxomatous tissue. The most common sarcoma of the breast arises in the intracanalicular myxoma. Why sarcoma is more frequently observed in neural fibroma than the myxomatous tumor in the region of the salivary glands, I cannot explain.

In one of the cases reported in my paper in 1920, in which the primary tumor was located in the astragalus, there was definite metastasis of pure

† Archives of Surgery, May, 1924, vol. viii, p. 882.

myxoma to the tubercle of the tibia after amputation above the ankle-joint (Case II, Fig. 11).

Unfortunately I have never been able to obtain the lung metastatic tumor in any of these cases of myxoma of bone.

Central Myxoma of Phalanges.—In the older literature which I have discussed in *Progressive Medicine*, and in my paper on Bone Cysts in the ANNALS OF SURGERY for August, 1910, cases of central myxoma of the phalanges are reported. This group of tumors in the phalanges of fingers and toes have been constantly restudied since. Unfortunately in not a single instance in which the original diagnosis was myxoma have we any sections to prove it. In all the recent cases in which we have tissue and sections none are myxoma—all are chondromas. Therefore, either the myxoma of the phalanges are less malignant, or the older diagnoses were incorrect. On the theory of probabilities, myxoma should now and then be seen in the phalanges, because this tumor occurs where the chondroma does, and it is suggestive that it is a degeneration of a primary chondroma, but the practical fact remains that the few cases diagnosed myxoma, situated in the phalanges and curetted without chemical or thermal cauterization have not recurred locally, nor given rise to metastasis. My colleague Doctor Baer of Johns Hopkins curetted such a case some years ago and has recently sent me an X-ray showing complete ossification. I remember distinctly the gross appearance in this case and my written report strongly suggests a myxoma, but tissues and section have been lost.

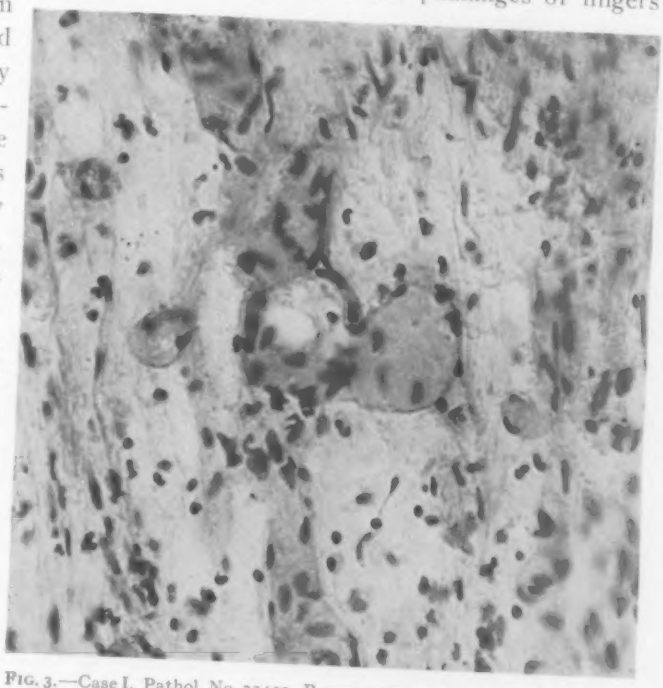

FIG. 3.—Case I. Pathol. No. 33423. Recurrent tumor tissue in a bone cavity. Observe the blood-vessels and blood mixed with myxomatous tissue.

For reasons which at present we do not know, all connective-tissue tumors arising from the soft parts and bone in the region of the phalanges of the fingers and toes are benign. We have only one example of sarcoma which was part of a multiple endothelial sarcoma of the phalanx of the great toe, tibia and femur.

I am rather inclined to feel that a surgeon exploring a central tumor of a phalanx and finding the gross and microscopic picture of a myxoma, would be justified in curetting with thermal (cautery) and chemical cauterization.

Central Myxoma of Metacarpals.—What has been said of the phalanx applies to the metatarsal and metacarpal bones.

Tumors of the Carpus.—Up to the present time I have never observed any type of malignant tumor of the carpal bones.

Central Tumors of the Tarsal Bones.—My experience has been with the astragalus and os calcis only. The possibilities are: bone cysts, giant-cell tumors and myxomas. The giant-cell tumor is the most common. There is no way of diagnosing it in the X-ray. If one explores a central tumor of the astragalus or os calcis and exposes a bone cyst or giant-cell tumor, curetting with thermal and chemical cauterization is sufficient. All of the cases of which I have records are well. Doctor Prince, of Rochester, has had an unusual experience with this group. If, however, the central tumor suggested in the gross and in the frozen section a myxoma, I would immediately burn the wound with the cautery, clean up the leg above the ankle and with a new set of instruments, *amputate,* in order to avoid the local recurrence and perhaps death from metastasis as recorded in Case II of my paper of 1920.

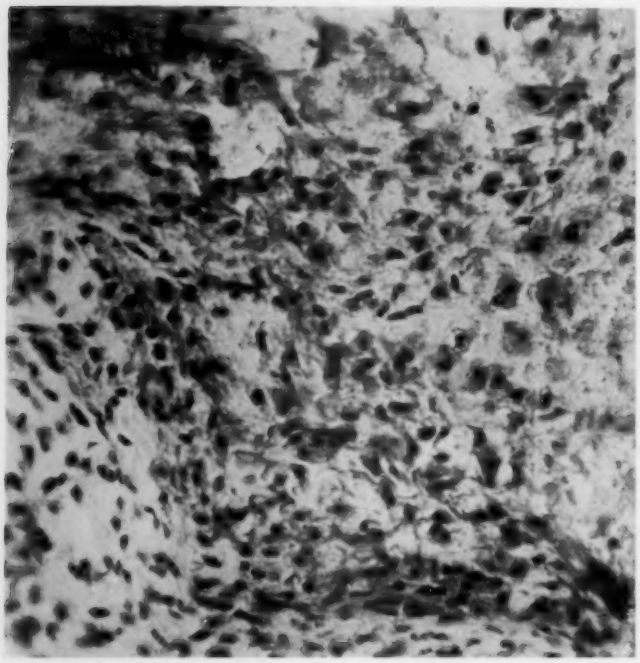

FIG. 4.—Case I. Pathol. No. 33423. A section from a recurrence two months later than Fig. 3. Typical myxomatous cells, but less intercellular myxomatous tissue.

Central Tumors of the Long Pipe Bones.—The problems of diagnosis here are easier, but the correct method of treatment for myxoma is not yet established, although one should be inclined to choose resection or amputation.

My studies up to date emphasize that the myxoma, either central or periosteal, is for practical purposes a sarcoma with a much greater tendency to recurrence from wound transplantation and with a longer interval before death from metastasis.

It is important to repeat here that all the older surgical pathologists as far

back as 1840 wrote: "The myxoma of bone is a benign tumor, but it always recurs after operation."

They did not observe their cases long enough to know of the metastasis. Many of my colleagues have not accepted this classification into central and periosteal tumors of the long pipe bones, which, as a matter of fact is not mine and not new. I am one of the few who look upon it as one of the fundamental facts established by the older observers of bone tumors.

More recent investigations allow some very positive deductions based upon

FIG. 5.—Case I. Pathol. No. 33423. Appearance of the wound August 25, 1923. There had been three intensive burnings with the soldering irons, in attempting to destroy all the soft parts about the recurrent tumor and all the cavities containing tumor in the trochanter and shaft.

the age of the patient and on whether the tumor involved the diaphysis or epiphysis.

When the patient is under eighteen and, more certainly, when under fifteen, a distinct central tumor of the shaft of a long pipe bone is always benign. The majority of cases are benign bone cysts, a very few—less than two per cent.—the benign giant-cell tumor, with now and then an isolated case of tuberculosis. I am looking now at the X-ray of a central tumor (due to tuberculosis) of the shaft of the tibia in a girl aged eleven years. The bone shell is intact (see Fig. 60, *Progressive Medicine*, December, 1900, page 2080). In the twenty years I have a record of but two other cases (see *Journal of Radiology* for March, 1920, Figs. 37, 38).

If the central tumor is in the epiphysis, and the patient is under eighteen and, more certainly if he is under fifteen, the tumor is usually a giant-cell tumor, but may be a bone cyst or tuberculosis. This localization in the epiphysis is very rare for the bone cyst, and this age is very uncommon for the giant-cell tumor.

When the patient is an adult and the central tumor involves the epiphysis,

FIG. 6.—Case I. Pathol. No. 33423. X-ray October 10, 1923. The patient is apparently well; the last section showed no tumor. The new bone formation outside the shaft and trochanter is largely the result of two previous operations and repeated cauterizations.

the chances are that it is a benign giant-cell tumor. But chondroma, myxoma and sarcoma are possible. When the central tumor involves the shaft of an adult bone, one can almost exclude a bone cyst or giant-cell tumor, and one must think of myxoma, chondroma, myeloma, metastatic tumors, and the very rare sarcoma. I am able to report three additional cases of myxoma since my paper in 1920.

Case I is chiefly of interest because the recurrent tumor in the shaft of the upper third of the femur has resisted repeated cauterizations with plumbers' soldering irons for a period of more than a year.

Had the operator in this case been familiar with the use of the cautery and the fact that a central tumor in the shaft of a long pipe bone of an adult is rarely a giant-cell tumor or a cyst, this thermal cauterization might have been employed at the time of the first exploration and curetting in June, 1922, instead of after the second curetting for recurrence in July, 1923.

Case II suggests that it is possible to recognize the central malignant tumor from the clinical history, in the X-ray and by palpation, and perform amputation or resection without an exploratory incision.

In Case III the operator, Doctor Rockey, was not suspicious of myxoma, or a central lesion other than cyst or giant-cell tumor in the lower end of the femur, but at the exploratory incision he recognized in the gross an unusual tissue and for this reason used the hot soldering irons. This patient is clinically well with a good functioning limb nine months after operation.

FIG. 7.—Case I. Pathol. No. 33423. X-ray September 25, 1924, before the last operation for recurrence. Compare with Fig. 6. There is an area of bone destruction and in this cavity tumor tissue was found.

CASE I.—Pathol. No. 23423. First observed July, 1923. *Central myxoma of the upper shaft of the femur* extending to greater trochanter; recurrent one year after curetting without chemical or thermal cauterization.

In this Case I have the tissues of the first operation and from the operations for recurrence, and of the last recurrence (September 20, 1924). The tumor is still a pure myxoma, both, in the gross and microscopic (see Figs. 1, 2, 3 and 4).

The next most important fact in this case is that in June, 1922, two years and four months ago, on the diagnosis of a bone cyst, the bone shell was opened and the contents curetted out.

There was no chemical or thermal cauterization.

On July 23, 1923, because of recurrence, shown by palpation, X-ray and pain, a second operation was performed by the same surgeon, and because of the profuse hemorrhage after curetting, the wound was packed.

FIG. 8.—Case II. Pathol. No. 34522. X-ray taken in 1920 and diagnosed a benign ossified lesion.

A few days later this wound was thoroughly cauterized with the hot soldering irons.

August 8, 1923, less than two weeks after the second operation, the patient was admitted to St. Agnes' Hospital, and the open wound again cauterized with the thermal cautery. This cauterization has continued at intervals for now more than one year. In spite of this at the last operation (September 20, 1924) pure myxomatous tissue was found in a bone cavity below the great trochanter.

The patient still walks with a cane, and for at least one year has been able to continue his work as a postal clerk. The cauterizations every three to six weeks under gas anæsthesia have kept him in the hospital from three to five days.

FIG. 8a.—Case II. Pathol. No. 34522. X-ray taken in 1920 and diagnosed a benign ossified lesion.

When I exhibited this patient before the American Surgical Association in May, 1924, the open wound was clean, and there was no gross or microscopic evidence of recurrence.

We have, therefore, demonstrated the failure of the thermal cautery and the deep X-ray to check or destroy the local growth of a recurrent central myxoma. At the present time there are no signs of metastasis to the lungs.

Clinical History (Case I), taken before the operation in June, 1922. First, there is a distinct history of a direct trauma to the region of the great trochanter of the right femur, in a white male aged forty-nine, whose occupation is that of a mail clerk. The pain after this trauma lasted but a few days, and there was an interval of almost two years before the occurrence of severe pain in the region of the great trochanter, upper end of femur, and sacro-iliac joint, and this pain had been present for more than one year before the operation in June, 1922.

FIG. 9.—Case II. Pathol. No. 34522. X-ray, lateral view, of myxoma of lower end of femur, shaft and epiphysis, with remains of the old lesion in the condyle shown in Fig. 8. Note there is no expansion; minute perforation of cortical shell; evident tumor shadow with, perhaps, some bone formation outside the cortical shell, both anteriorly and posteriorly.

Pain in Myxoma.—We have not a sufficient number of cases to come to any definite conclusions, but so far my records show that an intense, persistent pain in a bone lesion in which the X-ray shows an intact bone shell, is very suggestive of myxoma or rare sarcoma. I have, however, observed it on a few occasions in the giant-cell tumor, very rarely in the bone cyst.

X-rays and Palpation.—The surgeon who operated in June, 1922, reports that he could palpate a swelling below the great trochanter on the outer lateral surface of the right thigh with a distinct bone shell. The X-ray report notes a definite central lesion occupying the greater trochanter, extending to the shaft about the size of a hen's egg. The outer bone shell is thin, but the shaft of the femur and the great trochanter are only partially invaded. Unfortunately this X-ray film is lost.

Clinical and X-ray Diagnosis.—The one made at that time by the surgeon and the röntgenologist was *bone cyst*.

From my experience, the location and the age almost ruled out the bone cyst and the giant-cell tumor—too old for the bone cyst and unusual position for the giant-cell tumor. One should have thought of myxoma, chondroma or a possible sarcoma. The history of the intense pain also suggested the more

malignant types—myxoma and sarcoma. For this reason the patient should have been prepared for the immediate cauterization with a heavy soldering iron.

Gross Pathology of First Operation.—The operator informed me that there was no distinct connective-tissue lining as is usually found in the bone cyst, and no red, granular, vascular tumor so characteristic of the giant-cell tumor, but a viscid, whitish, thick fluid containing masses like tapioca. This almost describes the myxoma, and resembles the contents of the cyst found at the second operation.

FIG. 10.—Case II. Pathol. No. 34522. Antero-posterior view, not as clear as Fig. 9. The remains of the tumor shown in Fig. 8 are seen here in the internal condyle. This X-ray immediately should make one suspicious of myxoma or sarcoma. The disease has broken through the bone shell without expansion.

Recurrence After First Operation.—The wound healed, and the patient was relieved of pain for a few months. Then there were similar recurrent pains which radiated from the great trochanter towards the sacrum around the hip and down the thigh. A few months later a mass could be palpated, and recurrence was diagnosed by the original operator.

X-ray of Recurrence (July 1, 1923).—I examined this patient July 10, thirteen months after the first operation, at least eight months after the recurrence of the pain, and three or four months after the appearance of a visible and palpable swelling in the scar, and I examined this X-ray and further X-rays were taken by Doctor Kahn in my office. Unfortunately they have been mislaid or lost. (I took them with me to another city for a demonstration and returned without them.) But this X-ray and the ones which we have taken subsequently and which are reproduced here, differ very little from the description of the X-ray before the first operation, except that the cyst is larger; no marked destruction of the shaft appears in the X-ray. There is nothing in any of these X-rays to distinguish the type of tumor—it could be a cyst, a giant-cell tumor or a chondroma. In the X-ray taken after the first operation, I was surprised to find a reformation of the bone shell which had been removed, with considerable evidence of new bone formation toward the great trochanter, and a cavity the size of a hen's egg as described in the first X-ray. The larger part of the cyst was outside the trochanter and shaft, an expansion carrying with it the envelope of bone shell. The swelling at the time of my examination was fully the size of a grape-fruit (12 cm.), and, when I dictated this note

July 10, the patient was free from pain, there was no tenderness, and very little limitation in flexion and rotation at the hip-joint. The patient was walking without crutch or cane, and able to work. There were no signs of recurrence in the soft parts and, to repeat, a distinct reformation of the bone shell. For this reason I was rather inclined to the diagnosis of chondroma which had liquefied, because in myxoma, I rather felt from my previous experience that there would be recurrence in the soft parts. This case shows how difficult it is when the number of cases is small, to be certain of any conclusion based upon such previous experience.

FIG. 11.—Case II. Pathol. No. 34522. Longitudinal section through lower end of femur, formalin-hardened specimen. Compare with Fig. 10 (X-ray).

The patient returned home and, because of intense pain, the original operator explored, evacuated the contents of the bone shell and, as stated before, packed for hemorrhage. A few days later, at my suggestion he thoroughly cauterized the wound with soldering irons.

Pathology of Second Operation.—The material sent to the laboratory was a thick viscid fluid stained with blood and filled with small and large masses which consisted of opaque, gelatinous tissue not unlike tapioca, imbedded in tissues stained with blood. Fig. 1 is one of the larger pieces. Figs. 2, 3 and 4 show the microscopic appearance: certainly a myxoma, and some pathologists would say a myxosarcoma.

Fig. 5 taken August 25, 1923, after three intensive cauterizations at St. Agnes' Hospital, shows the open wound. Fig. 6 is an X-ray taken October 20, 1923, after repeated cauterizations, at a time when the patient showed no evidence of disease in the wound. Figure 7 is an X-ray taken September 25, 1924. You will observe that the area of destruction has appeared in the shaft below the trochanter, and in this cavity we found gross and microscopic evidence of tumor tissue. To repeat, there is no evidence of metastasis to the chest. The patient is free of pain, walks with a cane and continues at work in the Post Office Department.

Discussion.—I have called attention to this in previous communications, and the records of the bone tumors accumulated in the past few years emphasize the importance of this statement: No surgeon should explore a bone tumor without being prepared to cauterize the wound. The thermal cautery is far

stronger than any chemical cauterization, and fortunately the best cautery is the cheapest—the plumbers' soldering irons.

This case cannot be looked upon as a fair test of the use of the cautery in the treatment of myxoma. We shall have to follow the result in the third case. It does, however, confirm the conclusions of the previous papers on myxoma—its tendency to local recurrence. I am convinced that no local disease has ever received a more thorough treatment with the thermal cautery and the deep X-rays than in this case.

FIG. 12.—Case II. Pathol. No. 34522. Photograph of specimen to show soft part tumor in the popliteal space from perforation of the bone shell. The piece to the right is some muscle and fascia, sliced from the bone, exposing tumor tissue at *x*.

At this time (September, 1924) resection was out of the question and amputation, of course, meant hip-joint disarticulation. From previous experience amputation does not promise protection against metastasis. We have given this man a useful limb for two years since first curetting.

CASE II.—Pathol. No. 34522, observed January 27, 1924. *Central myxoma of lower end of femur involving shaft and epiphysis. Pure myxoma type.* First, deep X-rays, then amputation. Result, November, 1924, ten months well. This is the first time that I have deliberately made the diagnosis of a possible myxoma and amputated without exploratory incision.

The next most interesting point is that this is the first case in which I have an X-ray of the bone taken before the development of the tumor, and this bone showed evidence of a preëxisting and apparently healed central lesion of the epiphysis.

Previous History.—In November, 1920, three years and ten months ago, this patient, a white female then aged thirty-seven years, came under my observation and was operated upon for a benign tumor of the breast. At that time, because of pain in the right leg in the region of the knee-joint an X-ray was taken (Fig. 8). This was interpreted as a healed and ossified area of tuberculosis or a rare ossified bone cyst. I explored the knee-joint, found a little fluid, but a normal synovial membrane and cartilage. Microscopic sections showed no disease. This patient had been complaining of this joint for ten months, and has been using a cane for four months.

In the *Journal of Radiology* for March, 1920, I recorded a tumor of the lower end of

the femur—as far as I know, the first on record—in which an X-ray made July 1, after an injury was negative. As pain and disability continued further X-ray pictures were taken. Within five weeks an area of bone destruction was found in the external condyle, and the area increased in size up to September first, when the lesion was explored, and amputated on the diagnosis of a central sarcoma of the malignant hemorrhagic-cystic type. This patient is well more than five years, and the diagnosis has been changed by majority vote of Codman's registry, to a benign giant-cell tumor. The interesting part of the case, however, was a series of X-rays after the trauma with negative findings. The interesting and unique part of the case reported here is the X-ray more than three years before, picturing an apparently healed lesion.

FIG. 13.—Case III. Pathol. No. 34618. X-ray December 29, 1923, before operation. Note involvement of shaft and epiphysis; little or no expansion; suggestion of perforation anteriorly. Compare with Fig. 14, after operation.

Present History.—Whenever this patient wrote me she complained of pain in this knee. We were all inclined to look upon it as neurasthenic. For the past three months the pain has been almost continuous, of greater intensity; there has been some contraction of flexion, and the patient has had difficulty in walking.

Examination.—There is the expression of pain and fear. The involved knee is slightly flexed, there is visible swelling of the lower end of the thigh which, on palpation, is not fluid in the joint, but swelling of the soft parts. The only benign lesion of the bone presenting so much pain and tenderness was a central lesion of the upper end of the humerus in a boy of sixteen, reported in the *Journal of Radiology* for March, 1920. This patient is well after curetting only, and there is a difference of opinion in Codman's registry, as to whether it should be considered a sarcoma or a variant of the giant-cell tumor.

The point which I wish to emphasize again here is, that extreme pain and tenderness in a bone lesion without fracture and without evidence of inflammation is very suggestive of malignancy.

X-rays.—(Figs. 9 and 10.) The lateral view is better. Both views show a central light area involving shaft and epiphysis, invading the old healed area, recorded in the X-ray (Fig. 8) more than three years ago. The age—over twenty—is against bone cyst; the involvement of the shaft as well as of the epiphysis is against giant-cell tumor. Then we evidently see cortical destruction with a soft-part tumor shadow, outside the cortical layer. There is also practically no expansion. In my experience this X-ray should be looked upon as a malignant tumor, and this case shows that the pure myxoma may give the same X-ray picture as the central myxosarcoma or chondrosarcoma reported and illustrated in the *Journal of Radiology* for March, 1920.

Treatment.—We kept this patient at absolute rest in bed, except when she came to the office for X-ray treatment on crutches. Intensive radiation was given by Dr. Max Kahn from January 7 to 21. Intravenous salvarsan was given by Doctor Collenberg, although the Wassermann was negative.

The X-rays of the chest and all other laboratory examinations were negative. As there was no improvement of the symptoms, amputation was performed July 23, 1924.

Pathology.—Figure 11 pictures the myxomatous tissue in the preserved formalin

specimens. In the fresh gelatinous material exuded from the cut surface. Observe in the internal condyle the old ossified lesion infiltrated by the tumor. The sharp line of demarcation between the tumor and the marrow and the minute perforations of the cortical shell. Figure 12 at *x* shows a soft-part tumor outside the bone shell in the popliteal space which we can see in the X-ray in the lateral view.

Microscopically, this is a pure myxoma. As a matter of fact, there is no difference between a pure myxoma and a myxosarcoma. Both seem to have the same tendency to local recurrence, perhaps death from internal metastasis is later in the pure myxoma.

Result in Case II.—October 21, 1924, nine months after operation, the patient is well; no metastasis to the chest.

CASE III.—Pathol. No. 34618. *Central myxoma of lower end of femur.* Operation—curetting with hot soldering irons by Dr. E. W. Rockey of Portland, Oregon. Result: October, 1924, nine months, apparently well.

I am indebted for the record, X-rays and tissue in this case to Dr. E. W. Rockey of Portland, Oregon, and as far as I know, this is the first central myxoma to be attacked primarily with the thermal cautery. The tissues sent to my laboratory from this operation show pure myxoma.

FIG. 14.—Case III. Pathol. No. 34618. X-ray August 14, 1924, seven months after operation. Compare with Fig. 13. The central light area has now a more distinct ossified circumscribing shell. The perforation shown in Fig. 13 has ossified. All bones show slight osteoporosis. Compare the patellæ in Figs. 13 and 14.

X-rays Before and After Operation.—In this case I have an X-ray dated December 29, 1923, sent me by Doctor Rockey, and an X-ray taken in my office by Doctor Kahn dated August 14, 1924. The interesting question is: Can we tell the shadow of recurrence from the shadow of fibrous healing without ossification?

Let us compare the lateral views before operation (Fig. 13) and eight months after operation (Fig. 14). The chief difference is that the cavity, or light area, in the lower end of the femur and epiphysis is outlined in the picture after operation much more distinctly. In fact, the line of demarcation is as distinct as the cortical layer itself. The picture taken before operation shows a break in the cortical layer at the junction of epiphysis and shaft just beneath the patella.

Nevertheless the cavity which contained the tumor and which was burned out with the soldering irons is still unossified.

The comparison of the antero-posterior views (Fig. 15) before operation and (Fig. 16) after operation, as compared with the normal right leg after operation (Fig. 17), shows that the portion of the cyst extending up into the shaft from the external condyle, suggests ossification. In the pictures before operation (Figs. 13, 14, and 15) the internal condyle is apparently not

involved, while after operation there are light shadows suggesting either that the cancellous bone of the internal condyle was removed at the operation, or is the seat of osteoporosis from non-use. In Figs. 14 and 16 the left knee-joint, after operation, shows distinct osteoporosis from non-use, as compared with Figs. 13 and 15 of the affected limb before operation and Fig. 17 of the unaffected limb after operation.

FIG. 15.—Case III. Pathol. No. 34618. Antero-posterior view. The shadow of the patella overlaps the central light area in the external condyle. The line of demarcation between the tumor shadow and the marrow and shaft shadow above is different from that of any bone cyst or giant-cell tumor. Compare with Fig. 16, after operation.

I have studied this question before in a few other cases, and I find that in the majority it is impossible, at first, to distinguish in the X-ray light shadows of definite recurrence from light shadows due to fibrous tissue without bone, or osteoporosis from non-use. I had an opportunity some three years ago to compare two cases of giant-cell tumor in the upper epiphysis of the humerus; both submitted to curetting, one without chemical or thermal cauterization, the other with. At the end of one year, the X-ray shadows are apparently identical. The opening in the bone shell through which curetting had been done appears ossified in the X-ray in both. Yet, after this, recurrence took place in one, the first indication of which was definite local swelling and X-ray showing destruction of the bone shell. I have just seen an X-ray of the other case more than two years after curetting, and the cavity is not yet completely ossified.

So in this patient of Doctor Rockey this apparent ossification of the bone shell cannot be looked upon as positively excluding recurrence, nor the persistence of the light area as an indication of recurrence. This patient will have to be carefully watched, and if one sees evident destruction of the bone shell, or enlargement of the light shadow, this must be looked upon as a sign of recurrence.

Clinical Note.—This patient was examined in my office August 14, 1924, by Doctors Stewart and Cohn, and X-rays were taken by Doctor Kahn. It is noted that the patient is a white male, aged forty-nine. Two years before the operation in January, 1924, without a definite history of rheumatism and while driving his automobile, his left leg felt cramped and he was conscious of pain in the region of the left knee. As this continued he consulted physicians and was treated for rheumatism. When he came under

Doctor Rockey's care in December, 1923, an X-ray was taken. Doctor Rockey wrote me that from the X-ray he was inclined to the diagnosis of a bone cyst or a giant-cell tumor. The patient complained to him of pain for a period of two years and a recent limp.

Operative Pathology. (Doctor Rockey).—On exploring the bone over the tumor area the shell was so thin that it was broken by a retractor. A window was made in the bone shell and the cavity curetted and *thoroughly burned out with hot soldering irons* of various sizes. The wound healed per primam.

Microscopic Pathology.—Sections sent to me from this tissue showed myxoma.

FIG. 16—Case III. Pathol. No. 34618. X-ray August 14,1924, after operation. Most marked feature is osteoporosis; some ossification in shaft. No evidence of perforation.

Discussion.—What shall we do if this tumor recurs? Resection is out of the question. Even with a successful bone transplantation to replace the lower end of the femur, the resultant limb is never as useful. It is therefore a question between further curettings with the soldering irons and amputation. Even before my experience in Case I, I urged amputation in this case of Doctor Rockey. I practised it in Case II without exploration. Now that Doctor Rockey's patient is doing so well, I have no evidence that he runs greater risk of metastasis by further delay if there is a recurrence. However, when there are clinical and X-ray signs of recurrence, the evidence suggests amputation as the operation of choice.

FIG. 17.—Case III. Pathol. No. 34618. X-ray August 14, 1924, of the unaffected right leg, for comparison.

Conclusions in Regard to Central Myxoma.—(September, 1924.) If we leave out the possible central myxoma of the phalanges and metacarpals and consider only the long pipe bones and my one example in the astragalus, the conclusions made in December, 1920, hold good to-day. The only cases of myxoma or myxosarcoma which have been permanently cured, have been subjected to amputation or resection without exploratory incision.

Every myxoma explored has recurred locally, except this Case III of Doctor Rockey, in which the soldering irons were used and in which it is not yet one year since operation.

At the present writing I would choose resection without exploration, if possible, with bone transplantation. This might have been done in

Case I reported here, at the first operation. When resection and bone transplantation would not leave a limb with good function, primary amputation as in Case II, impresses me as the operation of choice.

There will be cases in which resection and amputation can be performed without exploration, because of the localization of the lesion and the character of the X-ray.

Undoubtedly in many cases one must explore. Then one should always have ready the cautery, the pure carbolic and alcohol, the fifty per cent. solution of zinc chlorid, and a technician to make a frozen section, and someone who can interpret it under the microscope. From my recent experience in cases in which I have actually seen the gross tissue, or in which I have obtained a clear description by the operator, I am impressed that all of them or the majority of myxomas of the bone, have a definite gross appearance so characteristic that any surgeon who really studies his gross pathology would be able to recognize it at the exploratory incision.

FIG. 18.—Photograph of plumbers' soldering irons and gas furnace. Total cost $35.

Is Curetting with Thermal Cautery Justified in the Myxoma?—Until Doctor Rockey's patient is followed for some years and shows no evidence of recurrence, one should not employ this method, but at once resect or amputate.

Chondroma.—I have called attention to the tendency of all chondromas to recur if the tumor is explored or removed piecemeal, and a piece of tumor cartilage left in the wound. This tendency is apparently almost as great as in myxoma, but up to the present time, although some of the patients have ultimately lost their limbs and a few have died of the local growth in the region of the vertebræ, none have succumbed to metastasis.

Brief Note on the Literature of Myxoma.—I reviewed the scanty literature in my article in the ANNALS OF SURGERY for December, 1920, but at that time I had not read my colleague, Doctor Cotton's paper, which I would like to briefly abstract here.

In the *American Journal of Röntgenology,* 1918, vol. v, Nos. 2 and 4, Cotton and McCleary, of Baltimore, report an example of a myxoma involv-

ing the shaft of the upper end of the femur, in a female aged thirty-five years. There were two exploratory operations between November, 1915, and the amputation of the hip-joint, November, 1916. In the first paper there are excellent X-rays and photographs of the gross.

In their second report, in the same journal, vol. vi, No. 12, p. 594, the authors report that this patient lived in comfort for two years, then there was evidence of recurrence in the groin and metastasis to the lungs, and death took place in April, 1919, almost four years after the first exploratory incision and two and a half years after the amputation. A marked feature of this case was the extensive involvement of the shaft of the femur, and at time of amputation both a central and periosteal involvement.

FIG. 19.—The different types of soldering irons.

In the second paper a second case is recorded, involving the shaft of the femur below the trochanter, in a male, aged forty-five years. The duration of the pain before operation was two years. The real lesion was not revealed until the X-ray was taken. An exploratory incision was made and the characteristic features of a myxoma exposed. The tumor was removed with chisel and curette. The wound healed in four months. There were signs of recurrence in six months, then amputation of the hip was performed. The patient succumbed in one year.

CONGENITAL TUMORS OF THE COCCYGEAL REGION

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Congenital tumors of the coccygeal region are of very rare occurrence. Comparatively few cases are reported in the literature. Standard text-books of Surgery and Pathology dismiss the subject with a simple statement that their development is obscure. Different writers reporting isolated cases have assumed different embryological mal-developments as the causative factor in all. The most generally accepted theories as to the causation of such tumors are (G. Herrman and F. Tourneux [1]):

1. Herniation of cul-de-sac of terminal meninges secondarily isolated.

2. Osseous and cartilaginous neoplasms from the lower end of the vertebral column.

3. Kystes dermoides formed by abnormal invagination of ectoderm having as a point of origin the so-called coccygeal fossette.

4. Coccygeal gland hypertrophy.

5. Persistence of post-anal gut.

Herrman and Tourneux [1, 2] offer an embryological explanation for the first of these theories. They describe the development in the embryo of a coccygeal remnant of the chorda dorsalis and trace its development through a series of embryos from the third month to birth. The description briefly is as follows: At the commencement of the third month of intra-uterine life, the medullary tube is prolonged caudally to the extremity of the vertebral column. The terminal segment corresponding to the last coccygeal vertebra becomes adherent to the skin. At the end of the third month the vertebral column begins to develop more rapidly than the spinal cord and meninges, thus pulling the medullary tube up into the vertebral canal, but leaving it attached to the skin. This results in an inequality and angulation of the caudal portion of the medullary tube, forming two branches: the "segment coccygiens direct" and the "segment coccygiens reflechi." During the fourth month the segment direct disappears. The segment reflechi persists and having undergone various modifications is found at birth. It is entirely separated from the remainder of the developing nervous system by the end of the fifth month. The structure is described as being roughly spherical and lined partly with stratified and partly with polyhedral columnar epithelium which retains its earliest embryonal characteristics. It is found entirely outside the vertebral canal and lies just anterior to the tip of the coccyx. A few polycystic tumors of the coccygeal region have been reported as present at birth. Two of these are reported by Herrman and Tourneux,[1, 2] and a few others have been reported by other authors. All of these probably developed from the "vestiges coccygiens" by which term the persistent "segment coccygiens reflechi" is known at birth. These tumors have been rather loosely called

neurenteric cysts without much understanding of the embryological factors involved.

Osseous and cartilaginous neoplasms from the lower end of the vertebral column undoubtedly could occur, but we were unable to find any direct references in the literature to such tumors as being present at birth.

Dermoid cysts of the coccygeal region, the so-called pilonidal cysts, usually develop later in life. They develop as painful masses which are usually small and are found about the tip of the coccyx. They are true dermoids containing hair, subaceous material, etc., and are occasionally malignant. They very often

FIG. 1.—Coccygeal cyst.

drain to the surface through a small sinus. Their development from ectodermal infolding from the ectoderm originally found attached to the tip of the coccyx, is comprehensively described by Navarre.[3]

Coccygeal gland hypertrophy was formerly thought to be a causative factor in a large number of congenital coccygeal tumors. At the present time this is not so generally believed, especially since the report of Vallois and Peyron [4] on the development of the coccygeal gland. These men, after an exhaustive study of the subject, come to the conclusion that the coccygeal gland develops from a plexus of blood-vessels derived from embryonic blood vascular channels corresponding to the caudal artery and vein of lower mammals. It is therefore strictly a blood vascular structure. At least one case which has been reported as arising from the coccygeal gland and described as being composed of epithelial elements, is open to a slight suspicion of having been derived from the vestiges coccygiens. (Burns.[5])

SCHMIDT [6] described a tumor of the coccygeal region in an eight months' fœtus which had been preserved in the Heidelberg Museum as a tumor arising from the coccygeal body. This tumor was quite large and was covered posteriorly by the skin and portions of the glutei. The sphincter ani was drawn backward by the mass and the anus stood wide open. It also extended well up into the pelvis. This tumor was polycystic and contained many small semi-solid connective tissue nodules. The tissues of the fœtus between the tip of the coccyx and tumor were sectioned serially and the coccygeal body was found in its normal situation and not affected by the tumor. On

account of this and other similar instances with which he was acquainted. Schmidt felt that the coccygeal body probably never gives rise to any tumor formation.

MIDDLEDORPF [7] reported a case of a tumor which undoubtedly arose from the post-anal gut. This tumor was removed at the age of one year, but had been present since birth. It was a small rounded semi-solid mass which extended from the sacrum anteriorly almost to the symphysis, practically covering the external genitals and the anus. There were two fistulous openings in it, from which discharged at times material resembling fecal matter. The baby was healthy in every way and its bowels had moved normally at all times. Dissection of the tumor showed that it had no connection with the rectum or sigmoid. Histological examination showed that it consisted largely of fatty tissue in which were imbedded tubules identical in structure with small intestine.

FIG. 2.—Showing result of operation for removal of coccygeal cyst.

Histologically all the layers of intestine, except the serosa, were found. He was not sure whether it represented a tumor arising from the post-anal gut or whether it represented a parasitic twin, but inclined to the former opinion.

From the foregoing brief résumé it can be seen that congenital tumors of the coccygeal region have been reported as arising from various causes. We wish to report a case of a congenital cystic tumor of the coccygeal region which seems to fall into that class of tumors, which according to Tourneux and Herrman,[1, 2] are derived from the vestige coccygiens. The case described is a single unilocular cystic tumor. Very few unilocular cysts have been reported. In fact, we were unable to find an original report of any. Several multilocular cysts of similar character have been reported however. Fowler,[8] in 1885, reported a multilocular cyst containing some semi-solid masses and gave a review of the literature up to that time. Huber,[9] in 1892, reported another, and a few others are on record.

Case Report.—Magee Hospital No. 3323. The baby, Italian, full-term female, was born February 1, 1924. Mother had previously borne seven normal children. Duration of labor 8 hours and 55 minutes. The delivery of head and shoulders was normal. The delivery of the rest of the body was delayed for several minutes by the presence of a large mass in the coccygeal region. This mass was almost as large as the baby's

head. The attending physician diagnosed the condition as a low spina bifida. The infant was fully developed and normal in every other way. Was admitted to the Elizabeth Steel Magee Hospital, February 7, 1924, service of Dr. B. Z. Cashman. General physical examination was entirely negative. The tumor mass was nearly as large as the baby's head and apparently covered only with skin. It fluctuated and was quite evidently cystic. The anus was dislocated downward and backward and stood wide open. Palpation of the tumor caused the infant no apparent discomfort. Rectal examination showed the absence of bony structures between the rectum and the tumor. Over the highest point of its surface, there were three somewhat widely dilated veins and the skin at this point was quite thin. The accompanying photograph (Fig. 1) gives an excellent idea of the appearance of the tumor. The mass increased somewhat in size during the eight days it was kept under observation prior to operation. X-ray examination gave no assistance in diagnosis. Plate showed a normal pelvis. On account of the increase in size of the mass, it was felt that some effort should be made to remove it, even though an exact diagnosis as to its character could not be made.

Operation.—February 15, 1924, Dr. B. Z. Cashman. Baby was placed on its right side, skin was prepared with alcohol, Harrington solution and picric acid. The skin and subcutaneous tissue overlying the mass were infiltrated with novocaine. Two incisions were made laterally over the mass in an elliptical manner and joined at their extremities. The wall of the mass was for the most part, just beneath the skin. The upper end was beneath the glutei, and dipper beneath the tip of the coccyx and extended upward anterior to the coccyx for a distance of about 2 cm. The mass was easily dissected free from surrounding structures, except when the median line was approached toward the tip of the coccyx. Its only firm attachment was anterior to the tip of the coccyx. Anteriorly it was separated from the rectum by a firm fascial layer. The external sphincter ani muscle was found to be pulled downward and backward over the cyst wall. When it was dissected free from the cyst wall it was seen to immediately assume the normal position and the anus closed. After the cyst was entirely removed the wound was closed with interrupted silkworm gut sutures.

The mass removed was seen to be a thin-walled cyst which contained amber-colored fluid with a specific gravity of 1.014. Microscopic examination of the centrifuged fluid showed the presence of a few cells which were apparently epithelial in character. Pathological examination showed the sac to be largely composed of connective tissue. The lining membrane had been evidently largely destroyed by the accumulated fluid, but in one or two places a lining of flattened simple epithelium was found and in other places the lining was composed of stratified columnar epithelium, thus again corresponding to the cases reported by Herrman and Tourneux[1, 2] as being derived from the vestiges coccygiens.

The baby made an uneventful recovery. The wound healed by first intention. X-ray examination of the baby after the wound was healed disclosed no abnormalities of the pelvic girdle, sacrum or coccyx. The anus was in normal position and the sphincter apparently functioning. Except for the scar and a certain amount of redundant tissue about the lower end of the scar, the baby was normal in every way when discharged from the hospital, March 14, 1924.

I wish to express my thanks to Dr. B. Z. Cashman for his kindness in permitting me to report this case, and to Dr. Davenport Hooker, Professor of Anatomy in the School of Medicine, University of Pittsburgh, for his great assistance in the preparation of this report.

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MELANOMA OF THE NAIL BED

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The subject of melanotic tumors occupies a conspicuous place in medical literature and is one which never ceases to be of the greatest interest. The admission to the Massachusetts General Hospital of a rather unusual case of melanotic malignancy, which was characterized by its originating in the nail matrix following trauma, and by its close resemblance to the ordinary paronychia, prompted a search of the literature for reports of similar cases. The examination of the literature showed that this particular type of case is one not frequently encountered, or not recognized as being malignant. The literature on the subject is admirably reviewed by A. E. Hertzler [1] in a rather recent article, in which he reports seventeen cases in all, including two of his own. As a survey of the hospital records netted only two cases in addition to the one mentioned above, it seemed advisable to report all three as exemplifying a rather unusual condition.

In reporting a number of these cases, Hutchinson [2] wrote under the title of "Melanotic Whitlow," although he recognized the fact that the condition was malignant. "There is a rare form of disease of the nail bed which is malignant, and usually takes the type of melanotic sarcoma. It is generally attributed in the first instance to injury, and its diagnosis is always missed in the early stages. Because it resembles whitlow, and is usually so named at first, I prefer to give it that name. It is, however, from the beginning malignant. Careful observation will find at the edge of the inflamed nail a little border of coal-black color, and this, however, slightly marked, must be allowed to make the diagnosis." Hertzler [1] in the report noted above selects the title "Melanoblastoma of the Nail Bed," which is excellent, as it describes adequately, yet tersely, the cases in question. In the present instance the term "melanoma" is preferred. A discussion of the connective tissue or epithelial origin of these tumors will not be undertaken here, as it is beyond the scope of this communication, which aims only to call attention to the characteristic features of these cases. These can best be presented by a brief consideration of the case histories.

Case I.—Hospital No. E. S. 750–131; M. C., age forty-two, single, white female, seamstress, was first admitted to the out-patient department, August 10, 1911. Her previous history was negative. The onset of the illness was February, 1911, six months before admission, when she first noticed a "crack" in the nail of her left thumb, which subsequently became infected. One-half of the nail excised and curettage done by her physician. The wound failed to heal and four weeks after the above treatment, "black specks" appeared in the unhealed area. On August 11, the note reads, "On the left thumb is a large indolent ulcer involving about one-half of the nail bed." At this time

there was no pigmentation, the ulcerated area was covered with clean granulations, and there was nothing, aside from the chronicity of the lesion, to suggest that it was not due to an infection of the nail bed, resulting in partial loss of the nail. On August 14 a small section was excised for microscopical examination which showed indications of "new growth." September 11 the thumb was amputated at the middle of the proximal phalanx. Microscopic examination of the specimen removed showed the characteristic large irregular cells infiltrating the tissues immediately below the epithelium together with varying amounts of pigment. (Fig. 1.)

The wound healed satisfactorily without any signs of recurrence. November 28, 1911, she again visited the out-patient department because of a swelling in the axilla and was immediately admitted to the wards. Physical examination at this time showed a poorly nourished woman, with a palpable gland in the left axilla, one inch in diameter, and two palpable glands, pea-size, in the left supraclavicular region. Chest negative; liver and spleen not palpable. Left thumb amputated just posterior to the distal joint. Operation by Dr. F. B. Harrington, consisting of dissection of glandular and fatty tissue in the supraclavicular triangle and axillary dissection was performed. The pathological report showed that only part of the glands were involved, the one large axillary gland on section being found to have undergone cystic degeneration, with the accumulation of a thin, reddish, hemorrhagic fluid. Microscopical examination of the involved glands showed "new growth" of irregular cells with eccentric nuclei. No pigment was found in the specimens examined. (Fig. 2.)

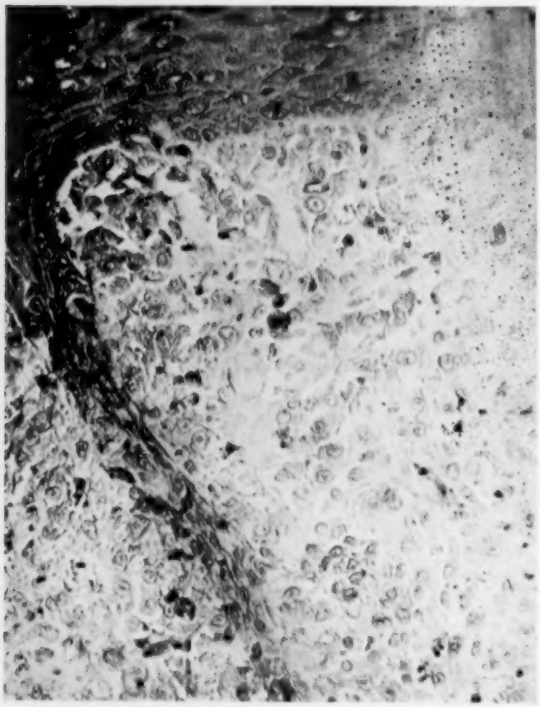

FIG. 1.—Case I. Path. No. 11-12-3. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of original tumor, showing normal epithelium with extensive infiltration of underlying tissue with tumor cells.

The post-operative course in the hospital was uneventful. She remained well without recurrence until July, 1912, eight months later, at which time the left elbow began to swell, with subsequent development of pain. The condition of the elbow became progressively worse and she was again admitted to the hospital, October 11, 1912, eleven months after her first admission.

At this time she presented the picture of one suffering from malignant disease. She had a persistent unproductive cough, weakness and was markedly undernourished. Abdomen negative. Chest negative. The left elbow showed a "round, deep purple tumor about five inches in diameter, chiefly on the inner side of the joint which was fixed at a right angle." (Fig. 3.) The whole tumor was extremely tender on palpation. The axilla showed the scar of the previous operation with a small hard, firm nodule the size of an olive in the anterior axillary fold. On October 14, amputation at the shoulder joint was performed by Dr. F. B. Harrington. October 27, a small "grape-size" nodule appeared

in the skin of the abdomen just below the umbilicus. This was excised and the pathological report was "Melanotic Sarcoma." On October 20, there was observed a similar nodule in the right infraclavicular region, while on November 5, a third was noted near the left anterior spine of the ilium. It being evident that the case was hopeless, the patient was discharged with the diagnosis "Melanotic Sarcoma with Metastases." The patient died January 8, 1913, two months after discharge and approximately three years after the onset of the disease, and thirteen months after her first admission.

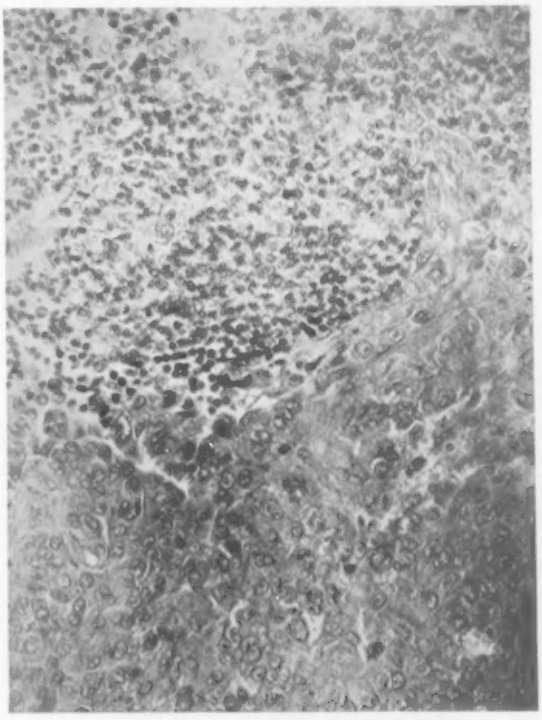

FIG. 2.—Case I. Path. No. 11-12-3. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of lymph gland removed from axilla at second operation, showing invasion of gland by "new growth," composed of irregular cells with excentric nuclei.

CASE II.—Hospital No. E. S. 237592; T. J. C., aged thirty-six, white, male, engineer, admitted to the wards July 10, 1920, complaining of "a sore on the right great toe." His previous history was negative. The onset of the present illness was two years before admission when, following slight trauma, the patient lost the nail of his right great toe. The lesion was cauterized frequently, but refused to heal, resisting all treatment. During the six months before admission, the granulations grew rapidly, in spite of frequent cauterization, so that at the time of admission the lesion had assumed all the characteristics of a tumor. On physical examination the chest and abdomen were negative. In the right groin there was a hard palpable gland the size of an almond. The right great toe showed the nail to be missing, being replaced by a tumor about the size of a walnut, irregular, rather firm, dark red or purple in color, and quite vascular. (Fig. 4.) There was considerable moisture and serous discharge on its surface. On July 12, amputation of the toe at the metatarsal phalangeal joint and dissection of the groin were performed by Dr. Beth Vincent. The pathological report on the tissue removed was "melanotic sarcoma with metastases to the inguinal glands." The patient was discharged on August 3rd, after an uneventful recovery.

FIG. 3.—Case I. Photograph of left arm, showing recurrence at the elbow, eleven months after excision of axillary glands.

Eight months later, March 26, 1921, the patient was again admitted to the hospital

with the diagnosis of "Metastatic Melanotic Sarcoma of the Brain," based on history and physical findings. He had had frontal headaches of increasing frequency and severity, some vomiting, gradually failing memory, and some speech difficulty. On physical examination the important points were, beginning bilateral choked discs, nystagmus on looking to right, paralysis of the left side of the face, some ataxia, marked memory defect, mental retardation. It being apparent that any operative procedure was hopeless, the patient was discharged April 2, 1921, and died five weeks later, approximately three years after onset and ten months after his first admission.

CASE III.—Hospital No. 258579, L. S., age seventy-two, white, female, widow, admitted to the out-patient department, November 4, 1922, complaining of "a sore on the great toe." Her previous history was negative. She dated the onset of the present illness five years before admission when she "bruised" her right great toe. Except for slight pain at the time, the patient experienced no discomfort and thought no more about the incident. Four days later, quite by accident, the patient discovered a small black area "like a blood blister" under the inner corner of the injured nail. This "spot" remained unchanged for one year. However, during the next four years, it increased slightly in size. When she presented herself to the out-patient department, the lesion was restricted to the area normally covered by the nail. The note at this time reads "exuberant granulations, bleeding readily, over the area ordinarily covered by the nail. A few shreds of nail about the periphery. X-ray negative except for atrophy of bone of great toe." The patient was sent home with instructions to return immediately if the lesion progressed noticeably. Six months later it suddenly began to grow rapidly. Contrary to instructions she did not return to the hospital immediately, so that at the time of admission to the wards, September 26, 1923, the toe was involved down to the middle of the first phalanx. It is interesting to note that although there was at this time a perfectly definite tumor, the condition was incorrectly diagnosed in the out-patient department, the patient being referred to the house with the diagnosis of "gangrene of the right toe."

FIG. 4.—Case II. Photograph of specimen removed at operation, showing tumor involving matrix of the nail which has extended beyond the limits of the nail bed. To the right, cross-section of lymph gland removed from the groin. Note areas of pigmentation.

Physical examination on admission showed the following: an obese elderly woman in apparent good health. Chest negative. X-rays negative for metastases. Abdomen negative. In the right inguinal region were several enlarged glands, almond-size, hard and firm. There was also a similar gland somewhat larger in the popliteal space. The right great toe showed a large irregular "bossy" tumor extending to the metatarso-phalangeal joint on the anterior aspect and to the midpoint of the proximal phalanx on the plantar surface. The toe nail was missing. (Fig. 5.)

The surface of the tumor was irregular, deep purple in color, with here and there

small areas deep black in color scattered throughout. There was considerable serous discharge. On palpation it was very hard, firm, "cartilaginous-like" and somewhat tender. A diagnosis of malignancy was made and September 28 amputation at the metatarso-phalangeal joint was performed by Dr. E. P. Richardson. The pathological report on this tumor was "Melanotic Sarcoma." The regional glands were not removed because their situation and extent were such that any interference with them seemed likely to produce a more rapidly fatal dissemination. The wound healed per primum and the patient was discharged October 15 after an uneventful convalescence. Examination of the patient three months after discharge revealed extensive metastases as evidenced by large palpable

FIG. 5.—Case III. Photograph of right foot showing tumor involving the great toe.

masses in the abdomen, marked increase in the size of the inguinal glands and considerable œdema of the legs.

The foregoing cases are all very similar to other cases reported and consequently serve as excellent examples. In each instance it will be noted that trauma to the nail antedates the subsequent development of the lesions, which is true in the majority of cases reported, although it is doubtful whether this is more than a coincidence or a stimulus to growth of a preëxisting lesion. Furthermore, we are dealing with a condition characterized at its onset by a period of extremely slow development. The duration of the period of quiescence, as it were, varies tremendously, as can be seen by comparison of Case I and Case III, the average being four or five years, although Boyer [3] reported a case in which the lesions remained stationary for twenty-eight years. On the contrary, once the initial lesion progresses noticeably, a rapidly fatal course is inevitable. Case I exemplifies the astonishing rapidity with which metastases occur, death taking place in this instance within three years after the trauma, and eleven months after the thumb first began to cause symptoms.

By far the greater majority of reported cases occurred in individuals over fifty years of age. In this respect Case I, and especially Case II, are a little unusual. Apparently males and females are affected about equally.

Clinically in its early stages, the lesion is apparently a paronychia, its earliest appearance being that of a small hæmatoma beneath the nail. Unlike the paronychia, this lesion gradually increases in size despite treatment, ulcerates and destroys the nail slowly until at length the latter is entirely lost. For the lesion to develop to this point requires a period of time varying from a few months to several years. To the casual observer, it now appears as red or purple exuberant granulations which bleed rather freely. However, careful observation will usually reveal small areas of black pigment either scattered through the lesion or around its border. The presence of pigment is pathognomonic, and furnishes the key to the diagnosis at this point. Following this stage in its development, it seems to attain some stimulus which causes it to progress with extraordinary rapidity and in a very short time it is quite evident that one is dealing with a new growth, as evidenced by the local tumor and enlargement of regional glands. From this point its progress is rapidly fatal, extensive metastases taking place throughout the body. Except for the inconvenience caused by the local lesion, the patient is comparatively free from symptoms. However, in some cases, pain and local tenderness may be rather severe during the later stages of its development, although this is by no means a constant feature.

Pathology.—With the exception of Case I, it would seem that these cases came into the hospital relatively late in the course of the disease. Both Case II and Case III presented easily recognizable tumors, consequently the diagnosis should have been obvious. However, Case III, in which the lesion was the most advanced, was admitted with the diagnosis of "gangrene of the toe." On the other hand, the lesion in Case I showed no characteristic pigmentation, but the duration of the condition was such that suspicion of new growth was aroused and a specimen excised for diagnosis. This represents the course which should be taken in a chronic progressive ulceration of the nail bed. It is desirable to obtain if possible an immediate diagnosis of the specimen, so that, if necessary, amputation can be carried out at once.

In the cases showing definite tumor mass, the latter was hard, irregular, deep red or purple in color, with here and there small areas deeply pigmented. (Figs. 4 and 5.) On section these specimens showed varying amounts of pigment. Case II showed a deep black outer zone, with a moist grayish base, without any apparent involvement of the underlying soft tissue. On the other hand, section of the specimen in Case III disclosed a uniformly brownish-black tumor which completely filled the soft parts, having destroyed the nail.

In the cases in which the region glands were excised, Case I and Case II, these were found to be firmly matted together. The individual nodes were markedly enlarged, hard and firm, presenting on section in both cases varying amounts of pigmentation. (Fig. 4.)

Microscopically these cases were quite similar and characteristic. The original lesion in each case was composed of large, irregular cells, showing all degrees of transition from round to spindle-shape, with large eccentric nuclei

(Figs. 1 and 6), with an indistinct alveolar arrangement. In many instances, these cells were in close association with the thin-walled blood-vessels. In two cases, Case I and Case II, mitotic figures were very numerous. Examination of sections of lymph-glands removed showed practically the same picture except that the pseudo-alveolar arrangement was a less prominent feature. On the other hand, the shape of the cells did not differ materially from that seen in the primary tumor. (Figs. 2 and 7.) However, Hertzler and Gibson,[4] in their cases, found that the primary cells were more nearly spherical while in the metastases the prevailing cells were spindle-shaped.

The distribution of pigment in these cases is very interesting. Hutchinson [5] called attention to many points concerning the distribution of pigment in cases of melanosis. "This mixture of colored and uncolored growth in melanotic sarcoma is, of course, common in all parts, but in none is it, I think, so marked as in the proximity of the nails." "When melanosis fungates and when it affects the glands, we must not expect the larger growths to be of black color. The power of producing black pigment appears to be, in most persons, very limited. The original growth beginning it may be in the site of the skin, or in the choroid coat of the eye is coal black, but the later and larger growths are white, or show only here and there a pigmented streak." [5] In the above cases, Case II and Case III, there was extensive pigmentation in the original growths. In Case I, in which glands were removed from the axilla at the second operation, they showed no pigmentation, although they were extensively infiltrated with tumor cells. (Fig. 2.) However, in the glands removed at the third operation, and in those removed from the groin in Case II, there was found considerable pigment both grossly and microscopically. (Figs. 4 and 7.)

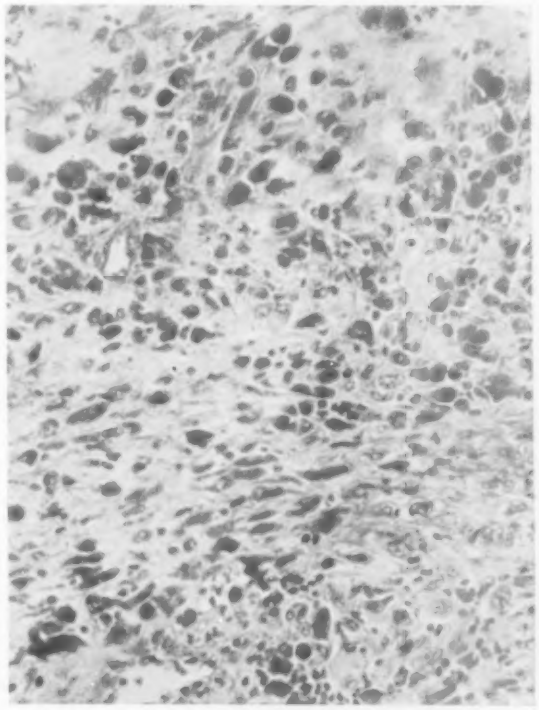

FIG. 6.—Case III. Path. No. 23-9-62. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of original tumor, shown grossly in Fig. 5, showing large irregular round and spindle-shaped cells in association with thin-walled blood-vessels.

The extent of the glandular involvement appears in some cases to be curiously dependent upon the amount of pigmentation in the original tumor. In those cases in which the latter is only partially pigmented, as in the above cases, the tendency to pigment formation in glandular metastases is most

marked. On the other hand, there are cases reported [6, 7] which are very interesting from the standpoint of metastases; where the initial tumor is of "utter blackness" and "the restriction of the growth during its earlier periods of its secondary reproduction, is, in a remarkable manner, restricted to the limb in which the disease originated." In these cases the lymphatic trunks of the extremity are found to be extensively involved appearing as beaded cords of coal black pigment, to the exclusion of glandular involvement.

Diagnosis and Treatment.—It is obvious that one of the greatest difficulties encountered in these cases is that of making an early diagnosis. It is impossible to say what the ultimate result would be if surgery were given the benefit of an early diagnosis, in accomplishing which several points are helpful. Careful and painstaking examination of the lesion is paramount, for the essential points of diagnosis are so delicate that they can be readily overlooked. Attention has been directed repeatedly to the fact, that although at first glance these lesions appeared to be simple ulcers, the surface epithelium is not completely destroyed.[1, 8, 7] The pigment often appears early in these cases in the form of "black specks" scattered throughout, or as a black border surrounding the lesion as pointed out by Hutchinson [2] and Hertzler.[1] This feature when present is extremely important, although in many instances its recognition is difficult. "To make the diagnosis at these stages, it is necessary to look carefully at the skin near the margin of the fungus. Here a little colored border may often be found, looking as if the lunar caustic had been applied, which tells the tale." [2] "It needs sometimes the eye of faith to recognize the narrow band of black which borders the inflamed part." [5] However, when the pigment is once discovered, the diagnosis is made. The presence of "black specks" or a "black border" is the key to the early diagnosis. Hence the importance of careful, painstaking examination of the lesion cannot be overemphasized. However, many cases show no pigment until relatively late in the progress of the disease.

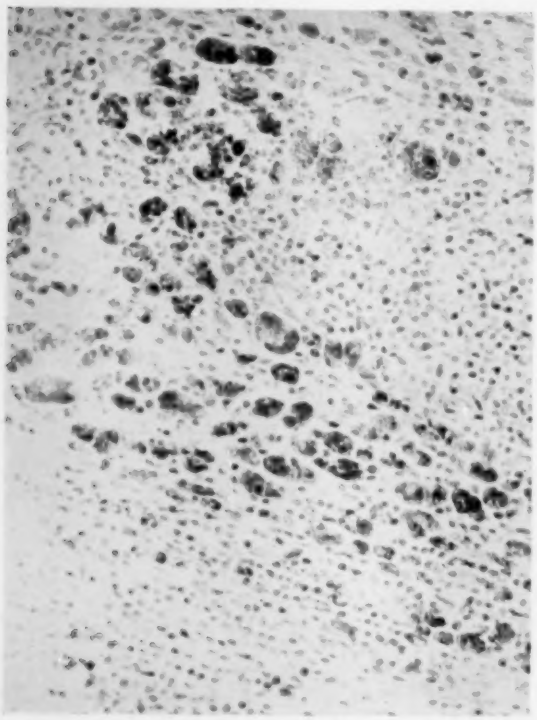

FIG. 7.—Case II. Path. No. 23-9-62. (Photomicrograph by Dr. A. E. Steele.) Photomicrograph of lymph gland shown grossly in Fig. 4, contrasting tumor cells with lymphocytes. Note intra and extracellular pigment granules.

Consequently chronic ulcerative lesions of the nail bed in elderly persons which do not respond to adequate treatment should be regarded with suspicion. In such cases, excision of a small amount of tissue for frozen section is indicated, but only if preparations are complete to perform immediately an amputation in case the diagnosis of malignancy is confirmed.

The treatment of these cases is radical excision. This means amputation of the digit and complete resection of regional glands as a minimum. The consensus of opinion is that Röntgen-rays and radium therapy are ineffective. The prognosis depends on early diagnosis, and is usually extremely poor when the lesion is finally recognized and hopeless when metastases occur.

SUMMARY

(1) Melanoma of the nail bed may occur.

(2) The condition resembles paronychia, but is chronic and shows pigmentation.

(3) Occasional cases may occur without obvious pigmentation.

(4) The diagnosis is ordinarily made late with the result that treatment is hopeless.

(5) This condition must be considered in all chronic conditions of the nail bed.

(6) Diagnosis should be confirmed by excision and microscopic examination of tissue, followed by immediate operation.

(7) In the three cases reported, the diagnosis was made too late to prevent death from general metastases.

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FRACTURES OF THE SHAFT OF THE FEMUR

TREATMENT BY MEANS OF BALANCED TRACTION

ANALYSIS OF IMMEDIATE RESULTS IN FORTY CASES

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The ultimate displacement of the fragments in a fracture of the femoral shaft is due almost entirely to the pull of the muscles which span the line of

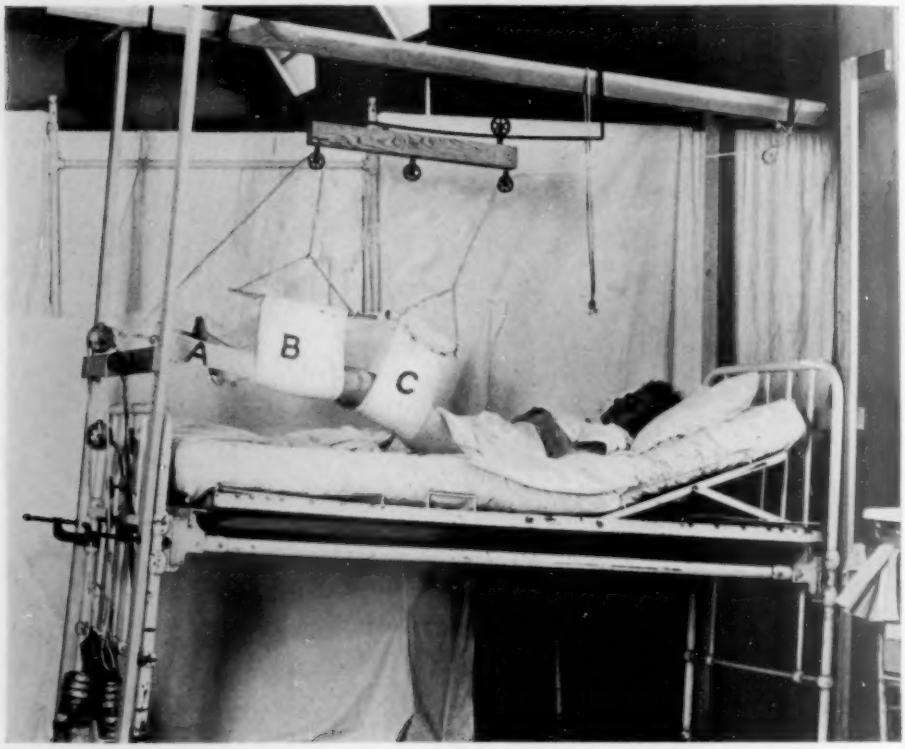

Fig. 1.—H. 5117. A. R., age 48. Comminuted fracture of lower third of left femur involving the joint with associated hæmarthrosis. A, traction straps. B, leg sling. C, thigh sling. Appliance to prevent foot drop has been omitted for a few days to obtain better relaxation of the gastrocnemius.

fracture. The violence, direct or indirect, which produces the break ceases to act as soon as the leg is placed at rest and the problem of reducing or fixing the fracture becomes largely one of the mechanics of muscle pulls. Could the force and direction of these muscle pulls be exactly counterbalanced, the fracture should theoretically reduce itself; and if the apparatus is so arranged as to exert a constant effect upon the fragments, the reduction should be maintained even though the patient moves about to some extent in bed.

The following is a preliminary report of the salient features of a method which embodies the above considerations. It has been successfully used in eleven cases of fracture of the femoral shaft which have been admitted to the surgical service of the Cincinnati General Hospital since July, 1923.

Traction, to be most efficient, should be applied with the limb in the position which puts the greatest number of muscles in a state of physiological rest. For the leg this position has long (Potts, 1768; Malgaigne, 1839[2]) been known to be one of semiflexion at both hip and knee. Traction in this position may be obtained by means of ice tongs or the Stinemann pin, but both methods have given rise to complications such as infection of the knee-joint or atrophy of the bone about the metal. In certain fractures, particularly in those of the middle third of the femur, the Hodgkin splint is efficacious but in this method, traction is exerted on the leg as a whole and cannot well be adapted to the particular needs of certain fractures, *viz.*: those of the upper and lower third.

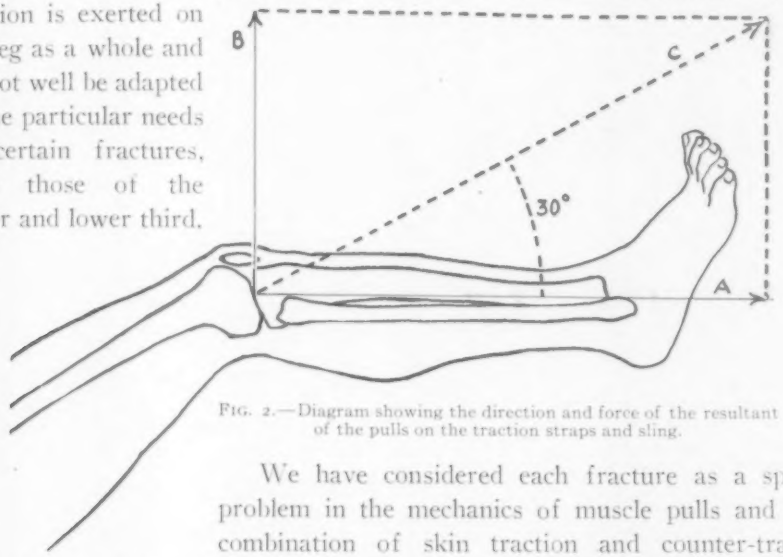

FIG. 2.—Diagram showing the direction and force of the resultant of the pulls on the traction straps and sling.

We have considered each fracture as a specific problem in the mechanics of muscle pulls and by a combination of skin traction and counter-traction have attempted to counteract the force and the direction of these pulls.

Method.—The leg is carefully shaved and cleaned with alcohol and ether and the malleoli protected with pads. Traction straps of ZnO adhesive plaster are then applied to the leg below the knee (Fig. 1, A) and fastened to a wooden spreader provided with a cord which runs over a pulley at the foot of the bed. To this cord is attached a weight which varies according to the age and the physical condition of the patient, but is usually from twenty to twenty-four pounds in a robust individual. A sling (Fig. 1, B) which extends from a point just below the head of the fibula to the malleoli is then placed about the calf of the leg and provided with a rod from which a cord passes through the lower pulley of the "traveller" of the fracture frame and over another at the foot of the bed. The system is so arranged as to make the pull on the sling act at right angles to the pull on the traction straps and with one-half its force.

The resultant of these two forces acts at an angle of 30° with the horizontal—or directly in line with the axis of the femur with the leg in semiflexion—and is equal to the square root of the sum of the squares of the two forces (Fig. 2, A and B). If equal amounts of weight be attached to the sling and traction straps, 45° of flexion is obtained and the resultant is equal to

the square root of $2A^2$. Thus by varying the amounts of weight we are able to vary the force of the pull and the degree of flexion to suit the requirements of a given fracture. When the upper fragment is abducted, as in many fractures of the upper third, the traction is applied with the leg in about 30 degrees of abduction.

Another sling (Fig. 1, C) is placed about the thigh, from which a cord runs through the uppermost pulley of the traveller and over the head of the

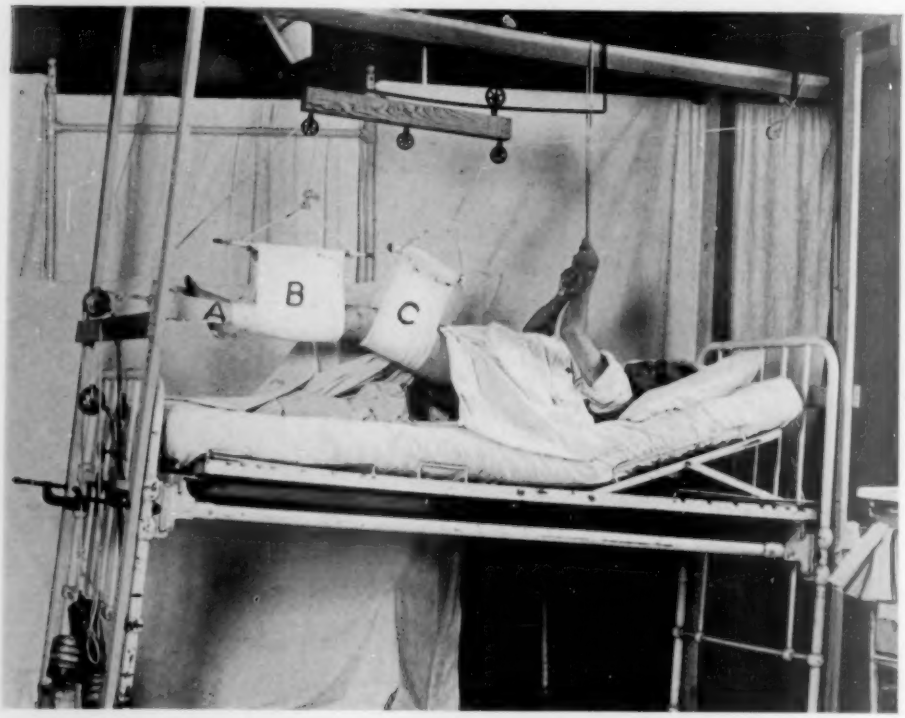

FIG. 3.—H. 5117. A. R., age 48. Showing freedom with which patient can move about in bed.

bed. To it eight to ten pounds of weight is attached. This sling serves at least two purposes. In fractures of the lower third it tends to draw the upper end of the distal fragment forward into alignment with the upper fragment. In all cases it acts as a coaptation splint which supports the thigh and prevents sagging of the fragments posteriorly due to gravity. Foot drop is prevented by traction applied to the sole of the foot, the traction cord with its attached weight running over the middle pulley of the "traveller." In fractures of the lower third this may be omitted for the first two or three days to obtain a better relaxation of the gastrocnemius. Counter-traction is obtained by raising the foot of the bed about eight inches from the floor.

Such a combination of weight and pulley traction permits of a considerable amount of movement on the part of the patient without in any way disturbing the force or direction of the traction. (See Fig. 3.) If the patient raises himself in bed, the weights immediately adjust themselves, and if he shifts

toward the head or foot of the bed, the traveller moves along its bar and keeps the pulleys in the same relation to the slings. The nursing care of such a patient is therefore much easier to carry out than is the case when other methods, such as immobilization in a spica cast, are employed.

FIG. 4.—A. R., age 48, 15th day. Antero-posterior and lateral views. Associated with hæmarthrosis of knee. Balanced traction maintained for 31 days. At present (6 months after accident) patient walks with only a very slight limp and has 75° of motion in the joint.

Since developing the above method, it has been our practice to apply it to cases of fracture of the shaft of the femur *immediately* on admission. It can be carried out without an anæsthetic and quite without pain. An X-ray is taken with a portable outfit as soon as possible after admission, but we have not waited for X-rays feeling that the early application of traction before massive infiltration of the muscles shall have taken place is an important

element in the success of the method. Usually no attempt is made at first to manipulate the fracture, but the reduction is left to the system of traction entirely.

Report of Cases.—Eleven simple fractures of the shaft of the femur have been treated by this method. One patient was a boy of eleven, one was

FIG. 5.—F. L. age 24, 15th day. Antero-posterior and lateral views.

seventeen; the remainder were adults, the oldest being sixty-four years of age. Four were females, seven were males. The site of the fracture was in the middle third in five cases, in the upper third in four cases, and in the lower third in two cases. In five the line of fracture was transverse, in three it was oblique, while in three comminution of the fragments was present. In one of the latter the line of fracture entered the knee-joint and was associated with a hæmarthrosis.

In 8 of the 11 fractures the first X-rays taken after traction was applied showed the position of the fragments to be entirely satisfactory and in two of the eight the reduction was almost anatomically perfect. In the remaining

three instances further adjustment of the traction was necessary, but in all of the eleven cases satisfactory reduction of the fragments was ultimately obtained. The average amount of traction used in male adults was twenty-four pounds on the traction straps and twelve pounds on the leg sling; in the females twenty pounds and ten pounds were sufficient. Ten and one-half pounds was the average pull on the thigh sling. However, in our later cases, we have used somewhat less weight with equally satisfactory results. If the first X-rays show the fracture to be in good position about one-third of the weight may be removed after two or three days.

The length of time that the traction was maintained varied from 17 to 57 days—the average being 33 days. All but one case showed quite firm union at the end of this time. This case—complicated by the presence of multiple fractures elsewhere—had delayed union, but firm union was ultimately obtained. After the removal of the traction further immobilization was employed in all but one case to prevent subsequent bowing. Single spica casts were applied in three patients, while five were discharged in ambulatory splints.

FIG. 6.—H. 7839. L. W., age 63, 40th day. Antero-posterior view. A very obese patient who would not tolerate a plaster spica and in whom an open operation was impossible due to cardio-vascular-renal conditions. Balanced traction maintained for 32 days.

Hospitalization Time.—The hospitalization period of these cases varied from 31 to 103 days, the average being 55 days. If we exclude the case with multiple fractures the average was only 50 days. This is 8 days less than a recently reported series of 40 cases treated by other methods.[2] In Eliason's series [3] the average stay reported was 63 days, and in Bosch's series [4] was 93 days.

Shortening.—In but one of these cases was there any measurable shortening of the involved leg at the time of discharge. This patient was a man who had two inches of shortening of the involved leg the result of an old arthritis of the hip and had customarily walked with the sole of his shoe elevated about two inches. He was discharged with 1¼ inches shortening, has had the lift removed from his shoe and at present, six months after his accident, is working at his former occupation.

Martin,[5] in reviewing 112 fractures of the femoral shaft in adults treated in Buck's extension, gives the average shortening as 1 inch. Bosch,[4] in 223

cases of all ages and treated by various methods, saw an average shortening of 1.7 cm., and Estes,[6] in analyzing 457 such cases, reports an average shortening of 1.5 cm. In a series of 40 fractures of this kind treated in this hospital by methods other than balanced traction, there was an average shortening of about 2 cm.

Angulation.—Three cases had slight angulation at the site of fracture

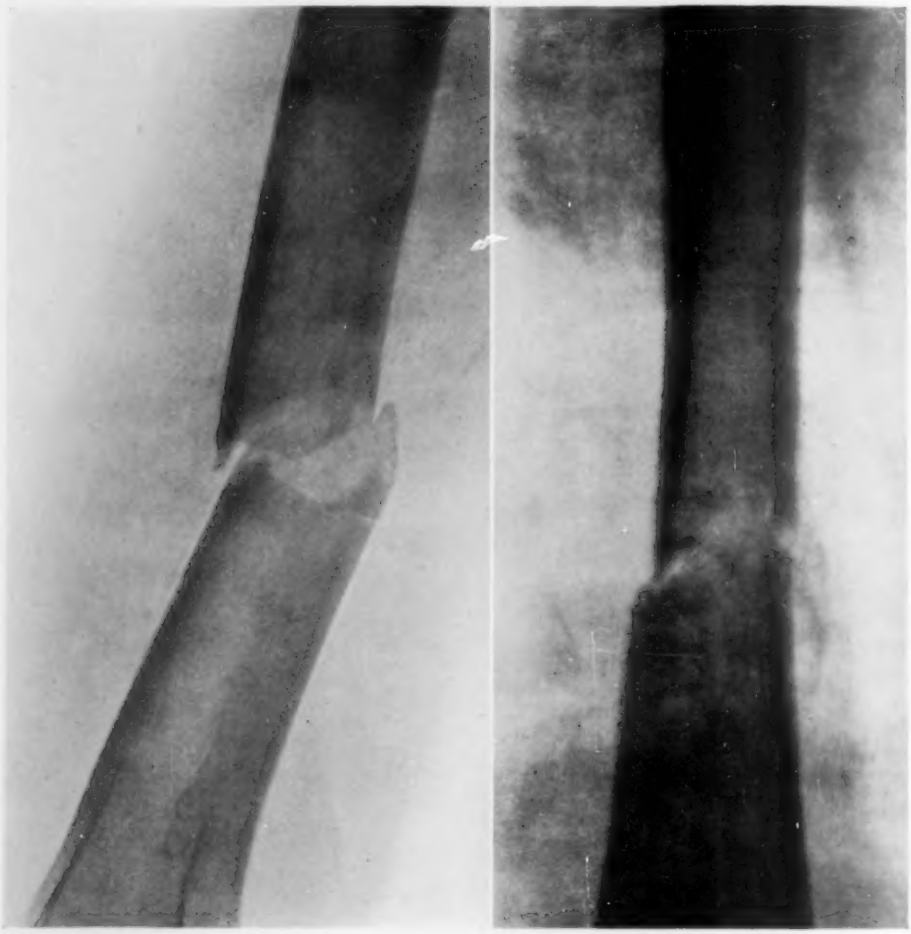

FIG. 7.—M. S., age 20, 57th day. Lateral and antero-posterior views. Multiple fractures elsewhere. Balanced traction maintained for 57 days. Union present but not firm at that time. Spica cast therefore applied for about 3 weeks. Discharged with firm union.

which was demonstrable only in the X-ray plates. In two cases the angulation was internal; in one posterior.

Joint Motion.—Ten of the eleven patients had at least 45° of joint motion at the knee when dismissed from the hospital.

Callus Formation.—All cases had callus which was both visible in the X-ray and palpable at the time of discharge.

Atrophy.—It has been our impression in comparing cases treated by this method with those in which prolonged immobilization in plaster was employed,

that there is little or no atrophy of the involved leg when traction is used. This impression has been confirmed by two cases in which comparative measurements of the two legs at the time of discharge failed to show any differences in the circumferences of the two.

Late Results.—Two cases are too recent to permit a report of the ultimate result. Of the remaining nine patients seen or heard from more than four months after discharge, seven have perfectly functioning limbs and are able to work at their previous occupations. One patient, in whom the fracture involved the knee-joint, walks with a slight limp, has 75° of motion at her knee and is rapidly improving under physiotherapy. Another, in whom the fractured femur was associated with multiple fractures elsewhere and union was somewhat delayed, left the city on being discharged and began weight-bearing too soon. A note from her present physician reports a considerable amount of bowing at the site of the fracture.

Summary.—1. A method for the treatment of fractures of the shaft of the femur in adults by means of balanced traction is presented.

2. The method seems to us to present the following advantages:

(*a*) Its application can be carried out almost painlessly without anæsthesia.

(*b*) It possesses all the advantages of skeletal traction with none of the disadvantages of the latter method and can be used in certain cases, such as those associated with marked swelling of the knee-joint in which the use of skeletal traction is attended with considerable risk.

(*c*) The traction alone, if properly applied, suffices to accomplish the reduction and fixation of the fracture in the large majority of the cases; eight of the eleven in this series.

(*d*) It permits the patient to move about in bed to a considerable extent without pain and without disturbing the force or the direction of the traction. The nursing care of such patients is therefore made much easier and their comfort increased.

(*e*) It can be successfully carried out in cases in which other methods fail or are not tolerated and in which open operation is contra-indicated, due to the physical condition of the patient, as in two instances in this series.

(*f*) There is less stiffness of the knee and less muscular atrophy following the use of this method than when casts alone are used.

3. Eleven simple fractures treated by this method are reported with an average hospitalization time of 57 days and with no measurable shortening on discharge in ten. In the other case the limb is probably no shorter than before the accident (v. s.). Ten had at least 45° of motion at the knee when discharged. Seven are already returned to their former occupations with excellent functional results.

The accompanying X-rays taken at various stages indicate some of the types of fracture encountered and the results obtained.

We have lately applied this method in the treatment of intertrochanteric fractures and hope that its principle may prove applicable to fractures of other long bones.

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An Analysis of the Immediate Results in Forty Cases of Fracture of the Shaft of the Femur.—This report deals with the forty fractures of the shaft of the femur in patients over twelve years of age treated on the surgical service of the Cincinnati General Hospital between January 1, 1922 and July 1, 1923. Only fractures below the trochanters are included.

Age.—The youngest patient in this series was 13 years of age; the oldest, 79 years of age. Dividing the cases into decades we find 8 cases or 20 per cent. between 12 and 20 years; 4 cases or 10 per cent. between 20 and 30 years; 6 cases or 15 per cent. between 30 and 40 years; 9 cases or 22 per cent. between 40 and 50 years; 6 cases or 15 per cent. between 50 and 60 years; while 7 cases or 18 per cent. were over 60 years.

Sex.—Twenty-six or 65 per cent. of these fractures were in males while 14 or 35 per cent. occurred in females.

Level of Fracture.—The upper ⅓ was involved in 5, or 12.5 per cent. of the cases; the middle ⅓ in 20, or 50 per cent. and the lower ⅓ in 15, or 37.5 per cent. The two sides were involved an equal number of times. In one case both femurs were fractured in the middle ⅓; the right obliquely; while the line of fracture in the left femur was described as transverse.

Type of Fracture.—The type of fracture was given as oblique in 13 cases (32 per cent.); as transverse in 13 cases (32 per cent.); and as comminuted in 14 cases (36 per cent.). When we analyze the types of fractures with reference to their location we find the oblique type equally distributed, the comminuted more frequent in the lower and middle thirds, while 10 of the 13 transverse fractures were located in the middle third. Thirty-three were described as simple fractures, while 7 were compound. One of the simple fractures was a pathological fracture due to metastases from a carcinoma of the breast in a woman fifty-three years of age; three of the compound fractures were gunshot fractures from revolver bullets.

Mortality.—There were 6 deaths; five from pneumonia in patients over

60 years of age; and one from bronchopneumonia complicating a lung abscess which ante-dated the fracture.

Treatment.—The emergency treatment in 30 of these cases consisted in immobilization in a Thomas splint. In 3 cases a spica plaster bandage was applied at once; in 3 the leg was placed in a padded basket splint; in 2 a plaster bandage had been applied at another hospital; in one Buck's extension was applied; and in another, a pathological fracture, sand bags were placed about the leg.

An attempt at reduction was made immediately on admission in 19 cases. In 9 an attempt at reduction was made within the first 24 hours; while in 6, more than 24 hours had elapsed between admission and any attempt at reduction. In the two cases admitted in plaster and in four other cases no primary attempt at reduction was made because of the condition and age of the patients.

Of the above 34 primary attempts at reduction, 11 including 3 primary open reductions, or 32 per cent. were successful; but if we exclude the 3 primary open reductions in compound fractures we find that only 8, or 23 per cent. of the 31 primary attempts at closed reduction were successful. This is about the same proportion of satisfactory primary reductions reported by Eliason [1] in his series. In 4 of these 8 cases spica plaster bandages, including the foot on the injured side, the pelvis and the thigh of the uninjured side were applied. In the other 4, immobilization in Thomas splints proved satisfactory.

Subsequently 58 attempts at closed reduction were made in the remaining 23 unsuccessful cases. These were as follows: thirty-six to immobilize in spica plaster; 4 in leg plaster; 13 in Thomas splints; and 5 in some form of traction apparatus. However, in only 14 of the 23 cases were reductions obtained which were considered satisfactory. The remaining 9 cases eventually came to open reduction; in 5 of which Lane plates were applied; in 3, Parham bands; and in 1 a medullary bone graft.

Of the 6 compound fractures treated, 3 had open reductions with débridement and complete closure within 8 hours of injury; two were immobilized in plaster with windows cut at the site of the wound; and 1 was put up in a simple Buck's extension.

Complications of Open Reductions.—In 12 open reductions infection occurred twice; once in the 9 simple fractures so treated; and once in a compound fracture which was grossly soiled on admission and was operated upon about 8 hours after injury. The plate became bent in one case and entailed a second operation. In another case a beef-bone peg which had been inserted into the medulla slipped and allowed the fragments to over-ride. Two cases developed pneumonia complicated in one by lung abscess; but both ultimately recovered. One patient developed tetanus 74 days after

sustaining a compound gunshot fracture of the right femur from which he recovered.

Results. Days in the Hospital.—The hospitalization period for the simple fractures treated by closed reduction varied from 43 to 151 days, the average being 58 days; while, for the 7 compound fractures the time varied from 84 to 403 days, the average stay being 149 days.

Pott (1768) and Malgaigne (1839), called attention to the importance of an early attempt to overcome the shortening and muscle spasm, and of placing the leg at rest before massive infiltration of the muscles should have taken place. And many others since (Bardenheuer,[3] Henschen,[2] Boorstein and Landsman,[4] Conference of American Orthopœdists on fractures at Boston 1922,[5] and others have pointed out that in almost all fractures an early immobilization of the fragments with at least an attempt at reduction influences, in no small degree, the subsequent course of the case and often the ultimate result.

This is nowhere better demonstrated than in fractures of the shaft of the femur in adults. If an attempt at immobilization is not made within a few hours after injury it is often impossible even under ether anæsthesia to overcome the shortening by manual traction sufficiently to permit a satisfactory apposition of the fragments. The heavy thigh muscles, shortened somewhat because of the break, soon become infiltrated with blood; and attempts to overcome this shortening become increasingly more difficult with the lapse of time.

With this in mind it is of interest to note the apparent effect of an early attempt at reduction on the hospitalization time in the simple fractures uncomplicated by other conditions. In 8 such cases in which an immediate attempt at reduction and immobilization was made the average time in the hospital was 69 days, the extremes being 35 and 116 days; whereas, in 6 others in which no such attempt was made until after 24 hours had elapsed the average hospitalization time was 103 days, the extremes being 71 and 121 days.

Union.—Of the 34 cases in which treatment was carried out, 31 had firm union at the time of discharge and were walking with crutches at that time. Of the remaining three, one was discharged in a plaster spica, one left the hospital against advice before it was time to remove the case, and the third was discharged in a "side-splint."

Shortening.—The average measured shortening on discharge (anterior-superior spine to tip of internal malleolus) in this series was slightly less than 2 cm. (1.95). In simple fractures it was 1.8 cm.; in compound fractures, 2.3 cm. Nine cases (three compound; six simple) had no shortening; while, the remainder had varying amounts, the maximum for simple fractures being 4 cm.; for compound fractures, 6 cm.

This also varied somewhat with the type of fracture, the comminuted fractures showing an average shortening of 1.3 cm.; the oblique, 2.2 cm.; and the transverse, 2.4 cm.

The fractures of the upper third showed the greatest average shortening (2.8 cm.), whereas, in the middle and lower thirds the average shortening was 1.75 cm. and 1.25 cm. respectively. These figures are influenced somewhat, however, by the fact that all the cases treated by open reduction which therefore allowed of more accurate replacement of the fragments were fractures of the middle and lower thirds.

Here again the detrimental effect of delay in the primary attempt to at least overcome the shortening present is evident. For in those uncomplicated cases to which extension was applied immediately on admission or in which an immediate attempt at reduction under anæsthesia with application of a plaster spica was made, there was an average shortening of 1.3 cm. On the other hand, in those cases in which no such attempts were made, the leg simply being placed in a basket splint or surrounded by sand bags, and an attempt at reduction made later, the average shortening was 3.5 cm.

Joint Motion.—In 9 cases there was no motion in the knee-joint on discharge. Thirteen cases had 30 degrees of flexion; 5 had 60 degrees of flexion; while in 2 cases, both boys of 13 years, there was full motion in the knee. The degree of joint motion was not recorded in 5 cases. In general the younger the individual the less is the liability to stiffness from simple immobilization. Also, in fractures of similar nature, those cases treated by extension, in the Thomas splint, for example, tend to have less stiffness of the knee than those treated in plaster.

Four cases had draining sinuses at the time of discharge; two of these had had open reductions and two were compound fractures in which no attempt at primary closure of the wound had been made.

SUMMARY

1. Forty fractures of the shaft of the femur (33 simple and 7 compound), are reported in patients from 13 to 79 years of age, with a 15 per cent. mortality.

2. Treatment in the majority consisted in primary immobilization in a Thomas splint with closed reduction and application of a plaster spica later. Several were treated entirely by means of the Thomas splint.

3. There were 12 open reductions with 2 infections (16.6 per cent.).

4. The average hospitalization time was 58 days for the simple and 149 days for the compound fractures.

5. The average shortening was 1.8 cm. in the simple cases and 2.3 cm. in the compound.

6. Three cases were discharged before union was complete; the remainder had firm union at the time of discharge.

7. Nine cases were discharged with no active motion in the knee; 13 with 30 degrees of mobility; 5 with 60 degrees; and 2 with full motion.

8. An early attempt at reduction and immobilization influences markedly the hospitalization time and the end results in fractures of this type.

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ASTRAGALECTOMY (THE WHITMAN OPERATION) IN PARALYTIC DEFORMITIES OF THE FOOT

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In 1916, one of the writers [11] read before the Orthopædic Section of the American Medical Association a paper on "Astragalectomy in Infantile

Fig. 1.—Astragalectomy—the Whitman operation. Line of incision.

Paralysis," which included a review of the literature of the subject up to that time, and covered a series of one hundred and thirty-five cases. In 1920, J. W. Sever [18] published an article in the *Journal of the American Medical Association*, reporting two hundred and seventeen cases of astragalectomy done at the Boston Children's Hospital, by eight surgeons. The results recorded by Sever are so diametrically opposite to those which were reported in the above paper that, in justice to the classical operation described by

Whitman,[22] we believe it necessary to make a further report of a series of two hundred and forty-seven of our own cases.

The Importance of Muscle Balance in the Foot.—The normal foot is balanced by muscles which work in perfect coördination, assisted by ligaments which check the extremes of motion. When paralysis involves the foot, the resultant damage varies from a slight, almost unrecognizable lack of muscle

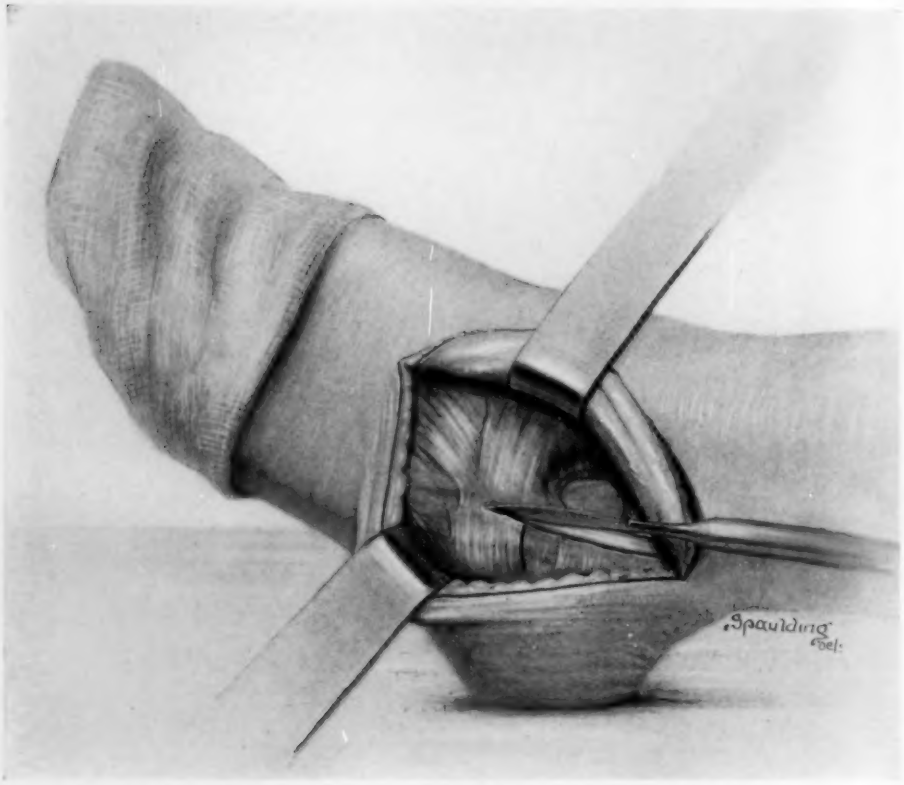

FIG. 2.—Tendon of peroneus longus exposed; tendon of peroneus brevis being exposed.

balance or weakness of a single group, to a complete paralysis of all the muscles. Lack of muscle balance causes two serious conditions, *instability* and *deformity*. The instability, which is greatly increased by the presence of paralysis elsewhere, may impair function out of all proportion to the extent of the paralysis. Deformity develops eventually in practically all cases from unopposed muscle pull. The recognition of this fact and the prevention of deformity are most important, since no reconstructive surgery can be done until all deformity has been corrected.

The Relation of Shortening (and Atrophy) to the Extent of Paralysis.—Instability, particularly with the additional handicap of deformity, is the major factor in determining the amount of shortening. The authors observed long ago that many severe and extensive paralyses developed only one or two

inches of shortening, whereas many cases with a single paralyzed group of muscles had as much as two to four inches. Analysis showed that patients using the leg well in walking developed less shortening than those using the leg poorly. Further, it was apparent that insecurity or instability of the foot caused the patients in the latter group to hop quickly over the weak leg, using it as little as possible. This explains perfectly why calcaneovalgus is asso-

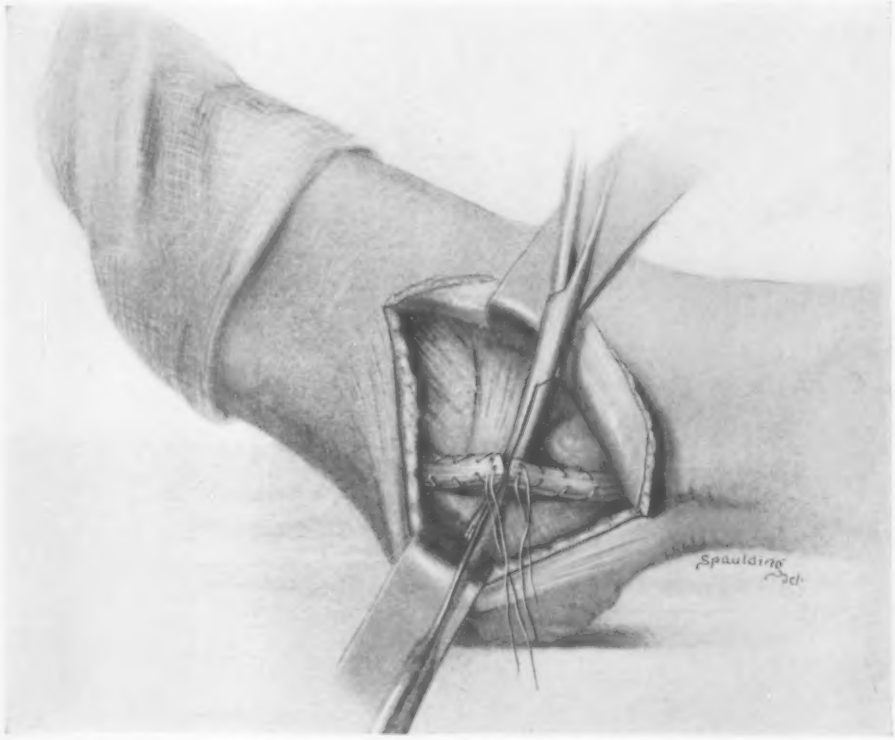

FIG. 3.—Peroneal tendons sutured and divided.

ciated with more shortening than one would expect from a single group paralysis; and, conversely, why almost flail legs vigorously used, show less shortening than one would expect. It becomes unnecessary to fall back on the term "trophic" to explain shortening.

Early "stabilizing" operations are amply justified to avoid shortening.

The Object of Astragalectomy.—The object of astragalectomy is to make a new ankle-joint (an arthroplasty) which, with such muscle as is present, will be stable and well balanced. When properly done, an astragalectomy shifts the weight-bearing line to the front by the forward displacement of the tibia and the fibula, thereby obtaining a so-called "rocking-horse foot," with the weight-bearing near the middle—the point of advantage—rather than on the "backstep of the rocking horse" as is clinically seen in a case of calcaneovalgus. The fulcrum is increased by the lengthening of the posterior arm or the distance between the weight-bearing line of the tibia and fibula

and the back of the heel. This change in weight-bearing is particularly efficient when the peronei are transplanted into the Achilles tendon, in which position they not only tend to prevent recurrence of calcaneous but in most cases may even assist in plantar flexion.

Astragalectomy not for Ankylosis but for Mobility (Arthroplasty).—There seems to be a widespread impression that the operation results in anky-

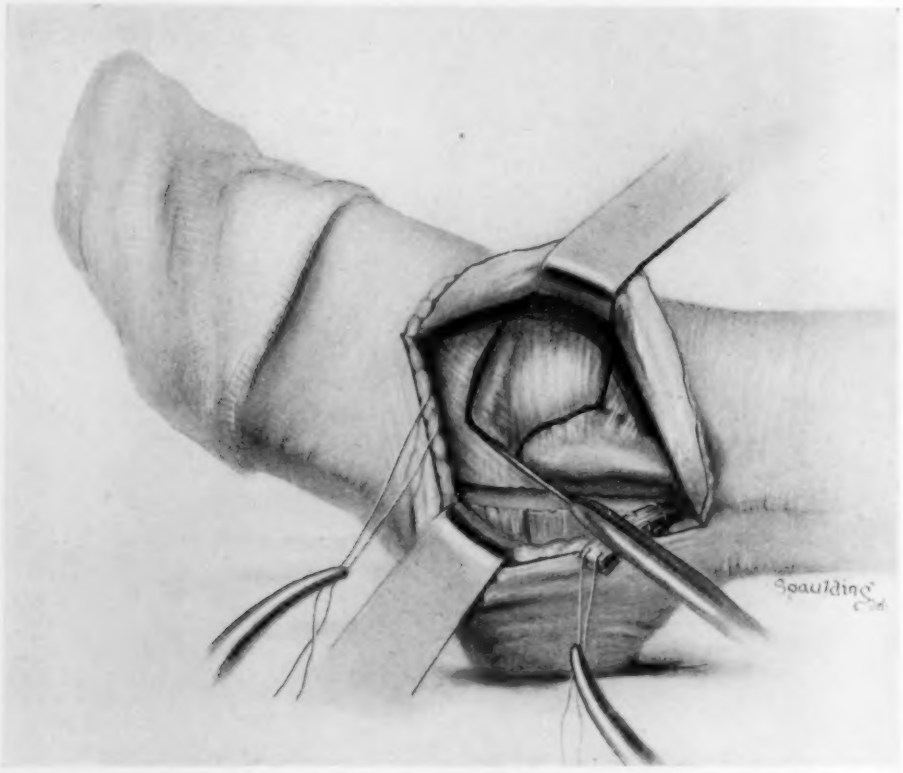

FIG. 4.—External lateral ligament divided; tibio-astragaloid ligament divided; interosseus and external talocalcaneal ligaments being divided.

losis, but ankylosis is neither sought nor expected, and if it does occur should be regarded as an unfortunate result. Astragalectomy has a distinct advantage over arthrodesis, in that it not only *stabilizes* but also *preserves motion.*

Indications and Contra-indications.—Astragalectomy should never be done in the presence of any structural deformity. This, if present, should be corrected by manipulative methods and the foot held in overcorrection for several months (walking being allowed) before astragalectomy. This necessary principle may have been overlooked in some of the many failures reported in the series from the Boston Children's Hospital.

Astragalectomy is indicated in *calcaneus deformities,* especially in valgus, for which it was originally devised by Whitman.[22] In calcaneovarus, it is important first to eliminate all varus deformity by repeated stretchings and by

retention of the foot in overcorrection. After months of overcorrection, astragalectomy may be done with safety.

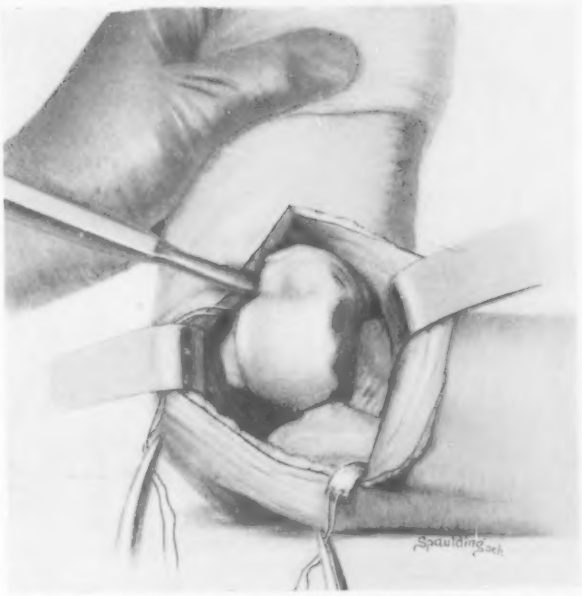

FIG. 5.—Dislocation of astragalus by strong inversion of foot. Note heavy dissector under neck by which astragalus is pried loose head first.

In *dangle-foot* astragalectomy results in stability, the weight being transferred to the centre of the foot, the arch elongated, and the os calcis made more horizontal. In cases in which only the plantar flexors remain, great care must be taken to prevent the deformity of equinis.

In *equinis* deformities (with no power in the anterior group) astragalectomy is useful in increasing stability, but great care must be taken to prevent a recurrent deformity. In severe *equinovarus*, after repeated stretching, the removal of the astragalus is frequently the coup-de-gras needed to complete and maintain a serviceable foot without deformity.

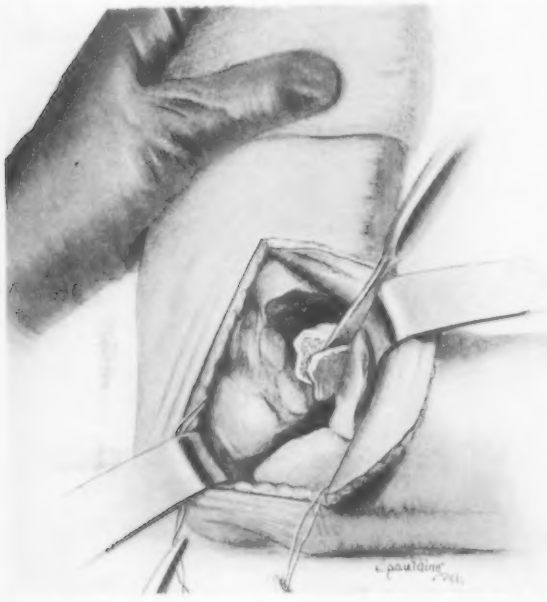

FIG. 6.—Widening tibia-fibular articulation by removal of thin slice of cartilage from internal malleolus.

Astragalectomy is very valuable in severe *claw-foot*. The great relaxation of the soft tissues occasioned by the removal of the astragalus gives the opportunity to save many feet that otherwise would be amputated. Slight or moderate varus and equinovarus may be treated by other methods.

Formerly we have included a few cases of *equinovalgus* in our list of astragalectomies, but the recent addition of the "loop" operation, also devised by Whitman, is replacing astragalectomy or astragalo-scaphoid arthro-

FIG. 7.—Widening the tibia-fibula articulation by removal of thin slice of cartilage from one or both; the internal lateral ligament has been dissected up to sharpen the malleolus.

desis in paralysis of the anterior tibial.

Age.—Any operative interference should be withheld until two years have elapsed since the original paralysis. It is neither necessary nor advisable to do an astragalectomy before this period. Also, we do not advise an astragalectomy before the age of six years, and it is better to wait until the child is eight years old. The ages between eight and sixteen years have been found the best, for in this period *motion is easily preserved.*

Operative Technic.—Asepsis should be guarded carefully and all manipulations should be gentle. A tourniquet is applied after the Esmarch bandage.

A curved or L-shaped incision is made around the external malleolus extending forward over the head of the astragalus. (Fig. 1.) The upper flap is then dissected upward, exposing the tendons of the peroneus longus and brevis, which are dissected free and severed at the fibular tip. The ends are sutured with No. 2 catgut and retracted. (Figs. 2 and 3.) An incision is then made through the external ligaments around the astragalus, special care being taken about the head of the astragalus. (Fig. 4.) The foot is then strongly inverted. By means of a blunt dissector placed under the neck of the astragalus the bone is pried out of position, head first,

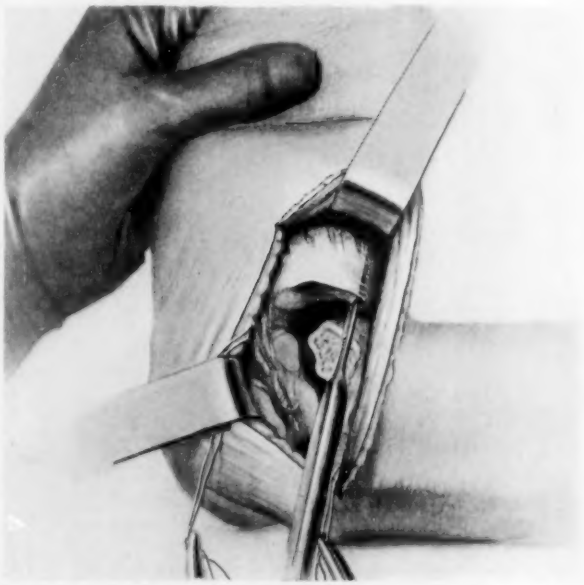

FIG. 8.—The new articulation for internal malleolus. Note removal of inner one-fourth to one-sixth from inner side of scaphoid, thus forming pocket for sharpened internal malleolus.

and removed—a veritable coup-de-main when well done, taking less than thirty seconds. (Fig. 5.) The ease with which the foot may be displaced backward will be appreciated at once, but in order to ensure a good, stable joint a certain amount of careful modelling must be done.

The internal lateral ligament is dissected upward from the internal malleolus, more in cases of equinovarus than in other cases. If necessary, a strip of cartilage is removed from both tips to allow spanning of the scaphoid and cuboid. (Figs. 6 and 7.) A thin slice of bone is then excised from the sides of the scaphoid and cuboid to form pockets for the malleoli. (Figs. 8 and 9.) The foot is displaced backward and held carefully in this position to ensure the proper relations in the new joint. This backward displacement of the foot which checks lateral movements by actual bony contact between the scaphoid and the tibia, is the essential feature of the Whitman operation. A moderate equinovalgus ensures stability while holding. (Figs. 10, 11 and 12.) The peronei are disposed of by (*a*) suture to the Achilles tendon, by (*b*) tendon fixation to the fibula, or by (*c*) resuture to the tendons of the peronei, as indicated in the given case. (Figs. 13, 14, and 15.) The skin is closed with catgut, and plaster is applied from the toes to the mid-thigh with the knee flexed and the foot in slight equinovalgus. (Fig. 16.) The leg is kept elevated for a period of ten days, after which crutches may be used. The first change of plaster case takes place in three or four weeks, at which time the equinus is corrected to a right angle in cases where the quadriceps is present, or is left in 5° to 8° equinus in cases in which the quadriceps is paralyzed. The mechanical value of this must be apparent. Valgus should persist to a slight degree throughout the treatment.

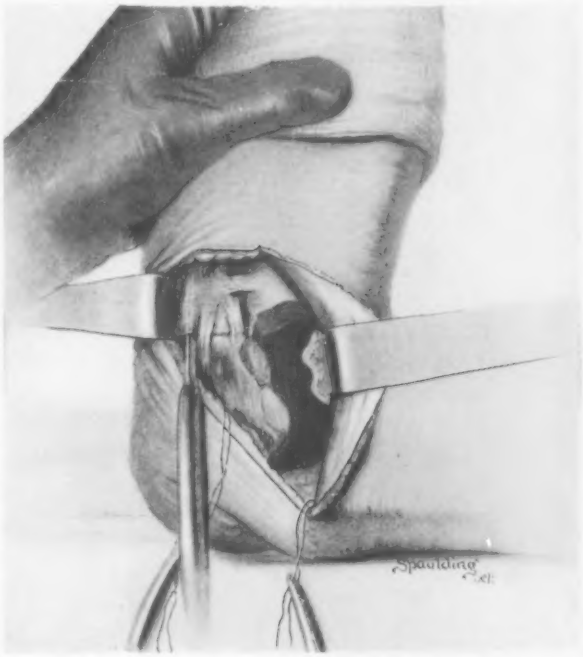

FIG. 9.—Dissection of ligaments up to make pocket for fibula by the cuboid.

A leather shoe is then put over the plaster and the child is allowed to walk, changing the plaster as necessary during the next five or six months. After its removal, a shoe with a lift on the outer side of the sole is used to maintain valgus. A one-half or three-quarters inch cork lift worn

under the heel throughout life will compensate for the shortening of the leg and improve the gait. Circulation improves rapidly with the return of active use, loss of growth ceases, and the paralyzed leg begins to grow at a rate equal to that of the well side.

After the removal of the plaster, it is sometimes advisable for older patients to wear a limited motion ankle brace, either in the form of an ortho-

FIG. 10.—Fibula and tibia being inserted into pocket.

pædic shoe or an inner or outer upright to protect the foot from strain during the early months of weight-bearing.

Steps in Technic.—1. Correct all existing deformities before open operation.

2. Astragalectomy may be done with or without tendon transplantation, tendon fixation of the peroneals or transplantation through the Achilles and resuture, with strong displacement of the foot backward.

3. Proper after-care. This should be followed by the operator and not by untrained assistants.

4. Prevention of Complications. Recurrent deformity is due to improper post-operative care.

Lack of posterior displacement is due to careless or improper operative technic, such as failure to remove head of astragalus. (See reproductions of X-rays accompanying Sever's [18] paper.)

We recently examined two hundred forty-seven cases operated from two to ten years ago. The majority of the cases were calcaneovalgus deformities, but varus, equinovarus, equinovalgus, and dangle-foot types were also represented. The age of the patients varied from three to twenty years, with an average age of eight to ten years.

In all cases of calcaneovalgus the peroneals were transplanted into the Achilles, with resulting increased function. In twelve cases, the peronei were

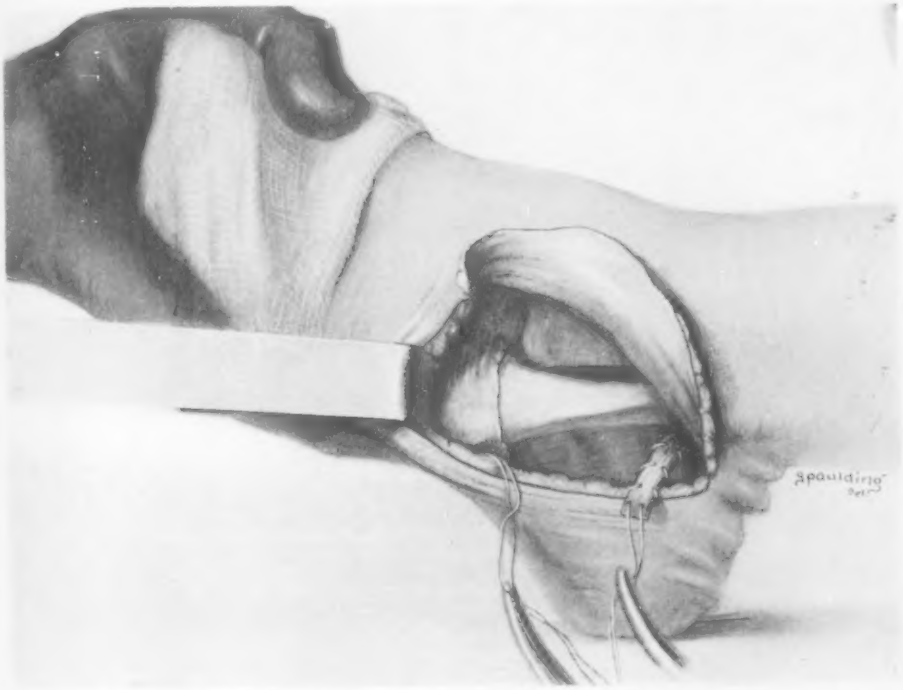

FIG. 11.—The external malleolus rests in a similar socket over calcaneo-cuboid joint. Note.—1, backward displacement of foot. 2, fibula carried well forward.

fixed to the fibula with satisfactory results. The foot was kept in plaster for an average of five months.

Out of the two hundred forty-seven cases, post-operative deformity developed in twelve, and of these varus developed in seven. In the later group, one patient refused after-treatment following astragalectomy; one insisted that the family physician change the cast; and the remaining five developed deformities from improper after-care in our hands. These, however, were corrected in every case before the patient was finally discharged.

One case of equinovarus deformity recurred. The patient did not return to the clinic for after-care.

There was one case of sloughing of the toe from swelling which developed because the patient was taken home and no attempt was made to keep the leg elevated; the end result was good.

The satisfactory results we have obtained lead us to recommend the Whitman operation in most cases in which stability with motion is desired.

ILLUSTRATIVE CASE ABSTRACTS

CASE I.—F. H. Age thirteen. Calcaneovalgus deformity. *Complaint:* Limp of the left leg. *Duration:* Nine years. *Cause:* Infantile paralysis. At four years of age, this patient had a "fever" resulting in paralysis of the left leg.

Physical Examination.—The left foot was held in calcaneovalgus deformity. There

FIG. 12a.—Normal relation of tarsal bones.

was power in the peronei and the outer dorsal flexors, but there was no power in the posterior or inner groups. There was one and three-fourths inches shortening, mostly in the lower leg. The quadriceps was present, although weak.

Treatment: October 14, 1919.—An astragalectomy was performed according to the usual technic. Plaster was applied with the foot in about 5° plantar flexion. The case above the knee was removed at the end of three weeks. New cases were applied on November 29, 1919 and February 24, 1920. About the fifth week, felt was put under the heel and the patient was allowed to walk on the plaster case.

March 20, 1920.—The cast was removed and a flannel bandage applied.

March 31, 1920.—The foot was in excellent position and the patient was advised to wear a three-eighths inch lift under the heel inside the shoe.

October 18, 1920.—The position of the foot was excellent, and there was good motion. A one and three-fourths inch lift was worn under the heel, a one and one-half inch lift under the sole, and a one and one-fourth inch lift at the toe. Of this amount, one-half inch was put inside the shoe at the heel and one-fourth inch at the sole.

April 16, 1923.—The foot was in excellent condition. *Result:* Good function.

CASE II.—J. Hart. Age ten. Calcaneovalgus deformity. *Complaint:* Lameness. *Duration:* Since seven months old. *Cause:* Infantile paralysis. The onset was sudden.

When seven months old the patient had infantile paralysis, and was in bed three weeks. At first both legs were affected, but later only the feet were in bad condition.

Physical Examination.—Calcaneovalgus of the left foot. Outer hamstrings absent; left thigh and gluteal muscles about one-half normal. No power in the calf muscles or in the extensors of the toes.

Treatment: May 27, 1919.—An astragalectomy was performed according to the

FIG. 12b.—Relations following the properly done astragalectomy.

usual technic and a plaster case applied with the foot displaced backward, and in slight valgus and equinus.

June 24, 1919.—The case above the knee was removed.

July 22, 1919.—A light plaster case was applied from the toe to the knee, and the sole reinforced with the foot at a right angle.

September 2, 1919.—A new case was applied. This was removed on October 28, 1919.

January 6, 1920.—The left leg was one and one-half inches shorter than the right. A one and one-fourth inch lift was worn under the heel, one-half inch of which was on the inside of the shoe. A one-inch lift with one-fourth inch inside the shoe was worn on the sole.

Result: March 1, 1921.—Examination showed an excellent result.

CASE III.—B. P. Age seven. Calcaneovalgus deformity. *Complaint:* Slight limp and turning of left ankle. *Duration:* Three to four years. *Cause:* Infantile paralysis. When the patient began to walk she had difficulty with balance.

Physical Examination.—Walked with marked pronated feet and heel was wabbly. Good dorsiflexors. Excellent peronei. No inner or posterior group. Astragalectomy with transplanting of peronei into the Achilles advised.

Treatment: May 1, 1923.—Astragalectomy was performed without transferring the peroneal tendons. Plaster applied in toe-drop, to be changed in three weeks.

May 31, 1923.—Case was removed and a new one applied. There was a slight serous discharge.

June 21, 1923.—There was still some sloughing. The patient began to walk on the case and bend the knee.

August 21, 1923.—The case had been removed when the scab fell off, and was replaced by a flannel bandage. The foot was at a right angle. There was 10° to 15° motion.

November 13, 1923.—Foot at a right angle. Massage advised to increase circulation. A one-quarter inch wedge put under heel to compensate for shortening.

December 11, 1923.—Walks with eversion of left leg, but with good foot balance. About 25° motion. No pain. Excellent displacement. (Figs. 17, 18, and 19.) *Result:* Good.

CASE IV.—M. C., Age six. Calcaneovalgus deformity. *Complaint:* Foot turned

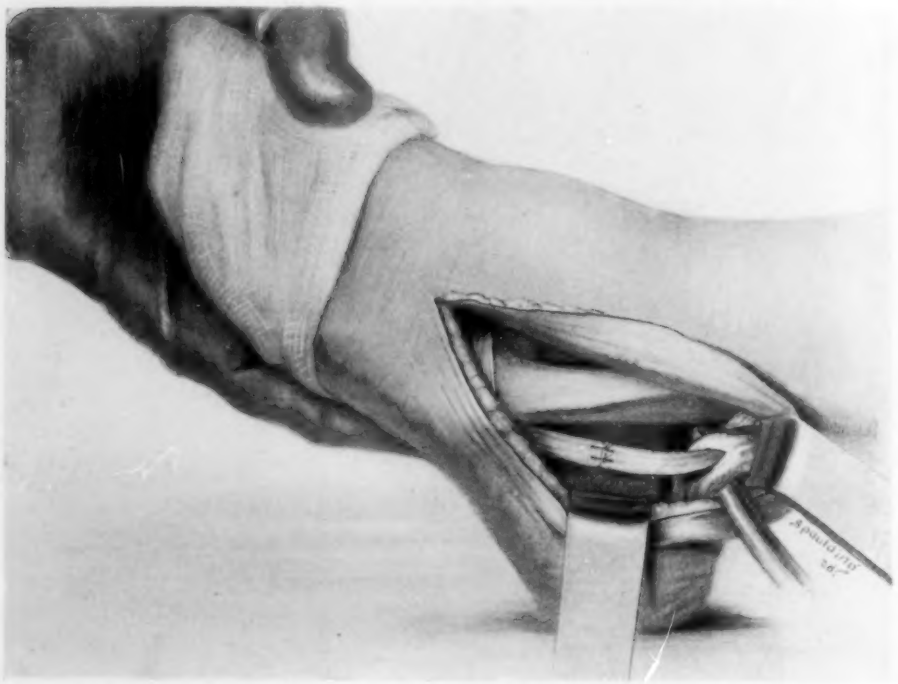

FIG. 13.—Disposition of the tendons of the peronei into the tendo-Achillis.

out. *Duration:* Three years. *Cause:* At three years of age patient had infantile paralysis which left her unable to walk. She gradually recovered, but the left foot did not respond to treatment and its condition grew worse.

Physical Examination.—The child walked with marked valgus of the left foot. The anterior tibial and peronei were present, although the former was weak. There was no Achilles or posterior tibialis. The left leg was one-half inch shorter than the right.

Treatment: May 24, 1913.—An astragalectomy and transplantation of the peroneals into the tendo-Achillis was performed according to the usual technic.

Result: December 22, 1914.—The functional result was good. The left foot was in good position.

CASE V.—M. O'B. Age eight years. Calcaneovalgus deformity. *Complaint:* Deformity of the right foot. *Duration:* Six years. *Cause:* Infantile paralysis.

P. I.—July, 1913. The patient entered the out-patient department with history of having had anterior poliomyelitis six years before. When first seen she complained of a limp and deformity of the right foot.

Physical Examination.—Negative except for the deformity of the right foot. The examination showed the absence of the inner and posterior groups of muscles. (Fig. 24.)

The patient was advised to enter the hospital for operation. A regular astragalectomy was performed, including the transplantation of the peroneal tendons into the Achilles and os calcis.

The convalescence was managed in the routine manner, and was uneventful.

Result.—The end-result was excellent.

Case VI.—E. D. Age eight years. Calcaneovalgus deformity. *Complaint:* Deformity of the left foot. *Duration:* Four years. *Cause:* Infantile paralysis.

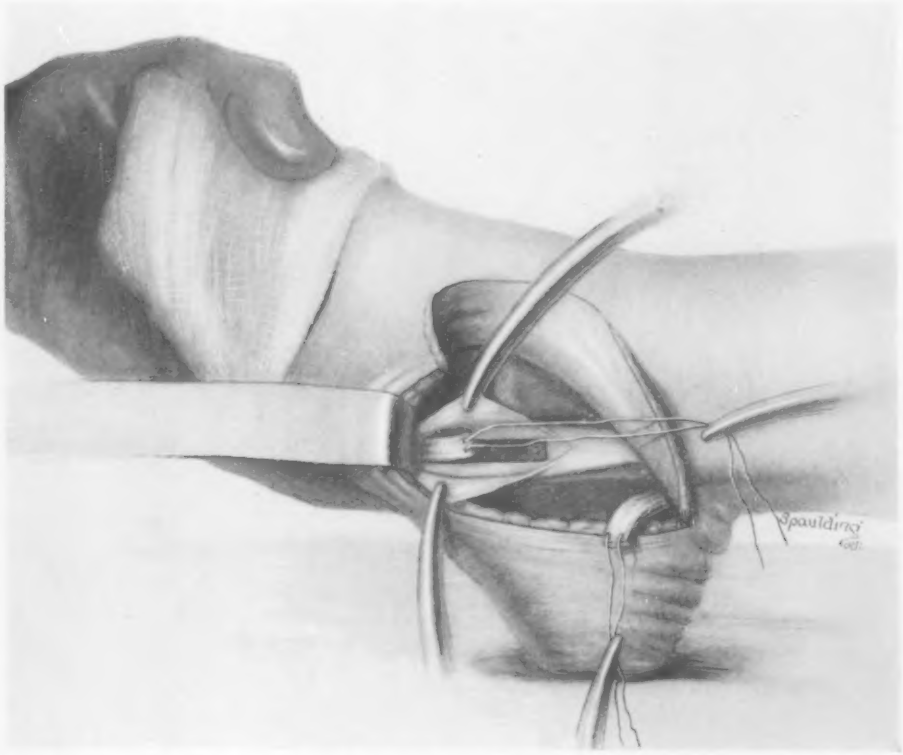

Fig. 14.—Disposition of tendons of peronei into the Achilles tendon and resuture and tendon fixation (Galli operation).

Physical Examination.—There were no contractures. The gastrocnemius and plantar flexors were absent. The quadriceps, anterior tibial and peroneal muscles were in good condition. There was shortening of one and one-half inches. The left foot was in calcaneovalgus deformity.

Treatment.—In December, 1914, an astragalectomy and transplantation of the peroneal tendons into the tendo-Achillis were done.

Result: January 22, 1924.—The foot was at a right angle and in excellent posterior displacement and good alignment. There was 10° motion in the mid-tarsal joint. The patient was wearing a lift under the heel and sole of shoe.

Case VII.—C. V. A. Calcaneovalgus deformity. This patient had a calcaneovalgus deformity on the left foot, due to infantile paralysis. A regular astragalectomy was done.

Result.—The result was good, with posterior displacement of foot in good alignment.

Case VIII.—K. M. Age four. Valgus deformity. *Complaint:* Left foot deformed. *Duration:* One year.

Cause.—Infantile paralysis. The onset was sudden; the patient on getting out of bed was unable to walk.

Physical Examination.—The child walked with a marked valgus of the left foot. The peronei were present. There was no anterior tibial. The tendo-Achillis was slightly

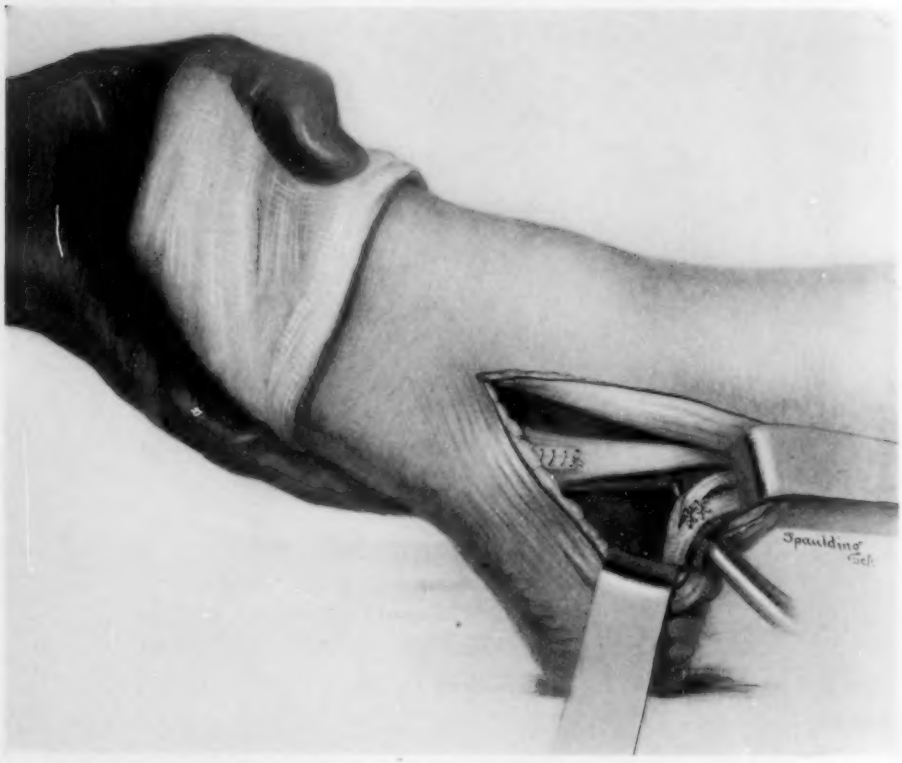

Fig. 15.—Disposition of tendons of peronei into Achilles tendon, and resuture of ends.

contracted. Abduction of the foot was not possible. The entire left leg was markedly atrophied.

Treatment: April 19, 1913.—A regular astragalectomy with transplantation of the peronei into the os calcis was done.

Result: June 4, 1915.—An excellent functional result was obtained. She walked well; motion from 85° to almost 180° was possible.

Case IX.—J. H. Age thirteen. Valgus deformity. *Complaint:* Walked with left limp. *Duration:* About twelve years. *Cause:* Infantile paralysis at the age of twenty-two months.

Physical Examination.—Left foot in marked valgus. Slight power in the extensors and Achilles tendon. No power in the tibialis anticus. (Fig. 20.) Glutei very weak.

Treatment: June 24, 1919.—Astragalectomy according to the regular technic.

August 5, 1919.—New case applied with the foot at a right angle. Patient began to bear weight.

November 18, 1919.—Case removed.

December 19, 1919.—Foot in fine condition. The patient was wearing a shoe with a one and one-half inch lift under the heel.

March 20, 1920.—The patient stood with the foot in slight valgus. The leg was two and one-half inches shorter than the right. A one and one-fourth inch bevelled lift was worn under the sole of the shoe, of which one-fourth was worn inside the shoe.

May 25, 1920.—The patient walked very well with shoe. Exercises begun.

Result: June 21, 1921.—An excellent result. The foot was at right angles, and there was good displacement and good control. There was flexion of 25°. (Figs. 21 and 22.)

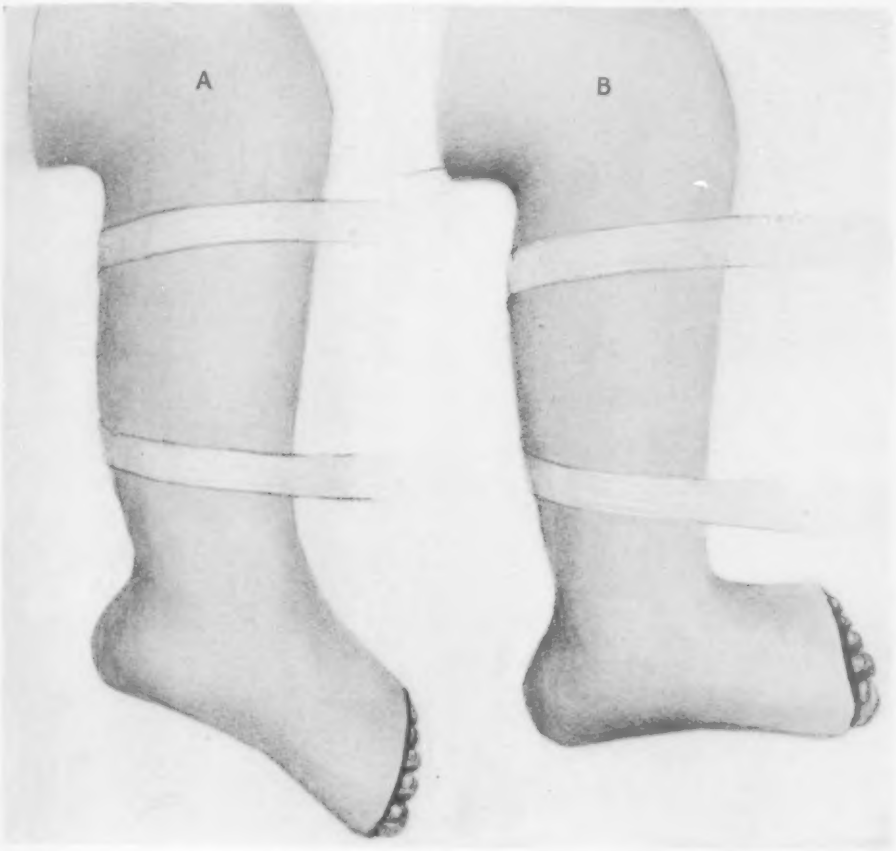

FIG. 16.—In plaster, following operation.

CASE X.—C. H. Age nine. Varus deformity. *Complaint:* Lameness. *Duration:* Six years. *Cause:* Infantile paralysis.

At three years of age this child had a fever which was followed by paralysis of the right foot that resulted finally in a varus deformity.

The foot was manipulated and the deformity corrected into a slight valgus.

On account of the general muscular weakness of the foot, as well as the absence of the peronei and the anterior muscle group, as astragalectomy was performed.

Two years later there was 25° motion in the ankle-joint. The foot was in good position and the patient walked splendidly. There was good stability and no pain.

CASE XI.—C. S. Age sixteen. Talipes equinus (extreme). *Complaint:* Lameness. *Duration:* Thirteen years. *Cause:* Infantile paralysis.

FIG. 17.—Case III, B. P., calcaneo-valgus deformity. Anterior view after astragalectomy (Whitman).

At three years of age this patient had a "fever" resulting in loss of use of the right leg. Improvement followed, but the right foot remained in extreme deformity.

Physical Examination.—Negative except for the contraction of plantar fascia and the Achilles. The peronei were present. The leg was one and three-eighths inches shorter than the left leg. The diagnosis was made of extreme talipes equinus, due to anterior poliomyelitis. The foot was manipulated and the plantar fascia contraction was first corrected.

May 19, 1914.—A regular astragalectomy was done, followed by the application of plaster from toe to just above the knee.

June 30, 1914.—A new plaster case was applied from the toe to the knee with the foot at a right angle. Several changes were made later, and the patient was allowed to walk on plaster with a three-eighths wedge under the heel.

July, 1913.—The functional result was good. There was good valgus, and the motion at the ankle was good.

CASE XII.—L. M. Age fourteen. Calcaneocavus deformity. *Complaint:* Walks with left heel limp. *Duration:* About twelve years. *Cause:* Infantile paralysis at the age of twenty months.

Physical Examination: August 7, 1923.—The left foot was in slight cavus. The leg, especially the calf, was atrophied. The iliopsoas, quadriceps and the tibialis anticus were strong. The gastrocnemius and the peronei had no power. (Fig. 23.)

Treatment: October 17, 1923.—Astragalectomy was done together with tendon fixation of the flexor longus hallucis to prevent plantar flexion deformity of the great toe.

November 27, 1923.—Ninety degrees to thirty degrees extension was possible.

January 22, 1924.—The case was removed and a flannel bandage applied. Massage of the calf was begun. The patient began to bear weight and was to begin walking as soon as possible, without a lift in the shoe. (Fig. 23.) Note posterior displacement.

FIG. 18.—Case III, B. P., calcaneo-valgus deformity. Lateral view after astragalectomy. (Whitman.)

Discussion of Doctor Sever's Report of Cases.—Our end-results are so different from those reported in Doctor Sever's[18] series, that it is interesting to try to explain the factors which account for the differences. We believe there are three:

1. *Failure to correct the structural deformity before operation.* One hundred and eighty-eight cases had deformity, but no mention is made of its correction before astragalectomy. Sixty-five cases had varus deformity, which should always be corrected before operation.

2. *Lack of proper operative technic.*—(a) Failure to remove the head of the astragalus. X-rays accompanying the report show that the head of the astragalus has not been removed. This fact is not noted in the report.

FIG. 19.—Case III, B. P., calcaneo-valgus deformity. Degree of motion after astragalectomy (Whitman).

(b) Failure to displace the foot properly. Sever admits failure due to lack of displacement in thirty-five per cent. of the fifty-four cases on which there is a note.

3. There are several factors in the operative technic on which Doctor Sever did not seem to be clear. The operation was originally designed for the calcaneus type of deformity, yet only fifty-two of the two hundred seventeen cases were of this type. The operation was also designed for cases involving paralysis of the gastrocnemius, but it was used in sixty-nine cases in which the gastrocnemius was active. Sever also appears to have anticipated a stiff ankle, which is not the aim of astragalectomy. Sever believed that the equinus position was the one sought by the operator, but this is true only in the absence of a quadriceps and even then only 5° to 8° toe-drop is advisable. In "Table No. 5" Sever records one hundred eight cases as having good "lateral movement." The object of the operation is to establish stability by limiting the lateral motion.

FIG. 20.—Case IX, J. H., valgus deformity. Lateral view before astragalectomy (Whitman).

Sever and his operators have failed in all the above essentials and their end-results might have been anticipated. We believe, as does Whitman, that the end-results and tabulations reported by Sever are of little value.

Literature.—Astragalectomy was first reported in the records of the Hospital for Ruptured and Crippled Children in 1897. Whitman [22] designed

it for calcaneus deformities of advanced degree, but its application has been broadened extensively and in a series of sixty cases reported more recently by Doctor Whitman [23] only sixteen were calcaneus deformities.

FIG. 21.—Case IX, J. H., valgus deformity. Anterior view after astragalectomy (Whitman).

Whitman's results certainly corroborate the value of this operation. Armitage Whitman,[22] in 1922, issued his report on a series of sixty cases, extending over a period of five years. Twenty-eight of these cases were operated upon by Royal Whitman and thirty-two cases by other surgeons. Ninety per cent. of the patients were satisfied with the results; sixty-five per cent. discarded braces. The best results were secured in calcaneus deformities. The causes of failure in their order of frequency were: insufficient backward displacement of the foot, varus deformity from faulty technic, persistence of the original deformity, and removal of the support of the head of the astragalus from the scaphoid.

Doctor Whitman bases the success of his operation on the proper selection of the cases, a thorough understanding of the mechanical principles on which the operation is based, exact operative technic, and appreciation of the deformity before operation, and of the recurrent distortion.

The Whitman operation has many advocates. Dane and Townsend [4] have reported three successful results, one for calcaneus deformity, and two for calcaneovalgus deformity. Gibney,[6] Taylor [20] and Albee [1] are in favor of it. Bradford [2] has found in his experience in the Boston Children's Hospital that the Whitman operation has given the best results.

FIG. 22.—Case IX, J. H., valgus deformity. Lateral view after astragalectomy (Whitman).

Tubby,[21] Lord,[10] Reed,[15] Campbell,[3] Rogers,[17] Orr,[13] and Gillette and Chatterton,[7] and Henderson [8] endorse the Whitman operation enthusiastically, particularly for talipes calcaneus.

Other surgeons have found astragalectomy of value in other deformities. Nathan,[12] and Henderson [8] consider that calcaneovalgus is corrected most efficiently by the Whitman operation. Gallie,[5] too, recommended it for extreme cases of calcaneovalgus and also for dangle-foot; Roberts [16] has secured many good results in typical dangle-foot. Stern and Cook [19] have reported that out of two hundred fifty

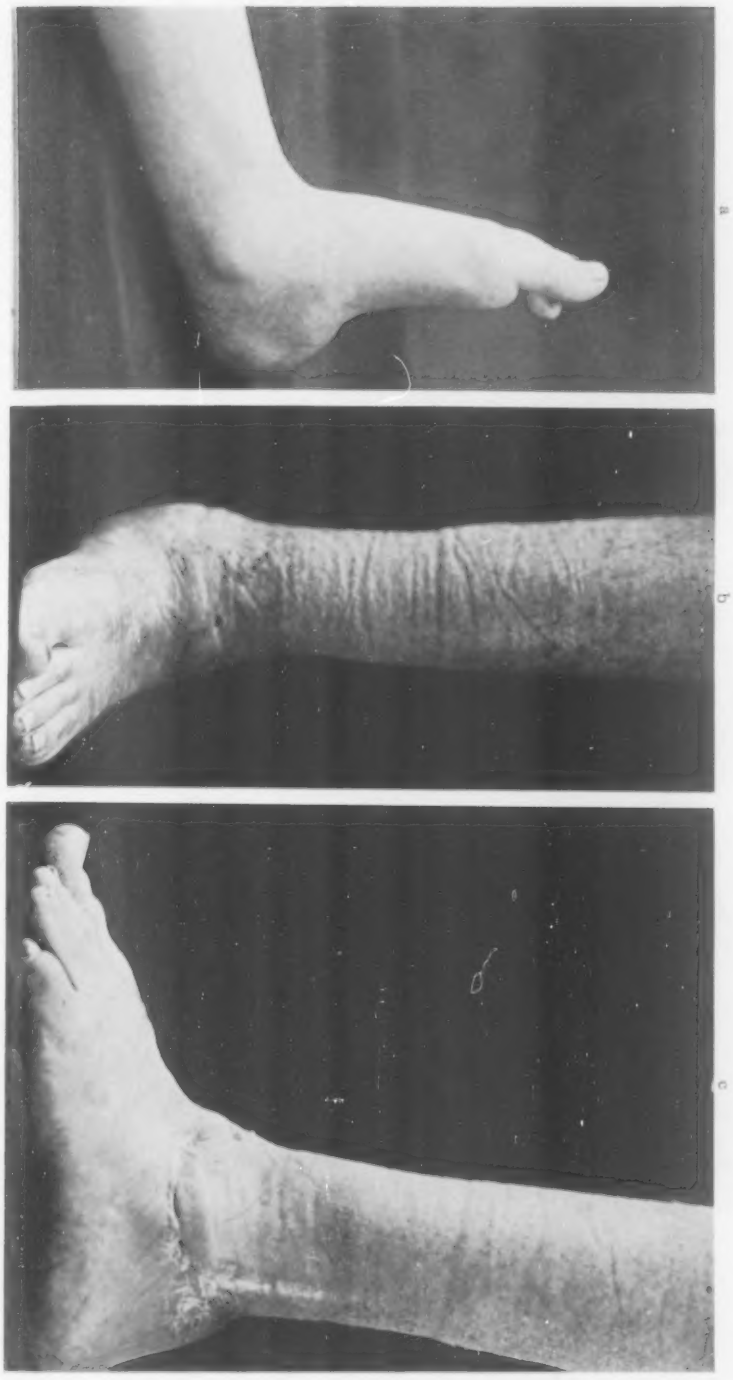

FIG. 23.—Case XII, L. M., calcaneocavus deformity. a, lateral view before astragalectomy. b, anterior view after astragalectomy. c, lateral view after astragalectomy (Whitman).

cases of astragalectomy that they investigated, only twenty relapsed and these could be corrected by a secondary operation. They recommend the operation particularly for paralytic talipes, talipes calcaneocavus, flail and dangle-feet in children ten to fourteen years of age. Packard [14] reported eight successful cases, six of flail ankles, one of marked calcaneovalgus, one of everted foot with toe-drop.

In discussion of Hoke's paper [9] on the arthrodesis operation, Wallace advocated the Whitman operation, particularly for calcaneous, calcaneovalgus, and dangle-foot. He has used or observed it in one hundred fifty to two hundred fifty cases and there has not been a case in which the patient was not materially benefited. He does not consider age a barrier to the operation, but believes that interference should be made two or three years after the original onset.

The many good functional and cosmetic results obtained from properly performed astragalectomy account for its acceptance as the operation of preference. It has gradually replaced many other operative procedures that have been devised to increase function in paralytic conditions of the foot.

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RADIUM IN THE TREATMENT OF PROSTATIC CARCINOMA*

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1. *Method of Radium Treatment.*—Both Young and Bumpus have, in their reported cases, attempted to and succeeded in confining the radium application to a carcinomatous prostate to one series of treatments, extending over at most a number of weeks. Their treatment has been rectal, intra-prostatic, by needles and intra-urethral. In this way, 1900 to 2500, and even 4000 or 5000 milligram hours, have been given within a short time—weeks. Our routine at the Memorial Hospital is perhaps no better, but certainly quite different. We give the radium by needles, introduced through the perineum, placing the needles 1 to 2 cm. apart throughout the carcinomatous prostate, and passing other needles up into the seminal vesicles. These latter are sometimes introduced through the rectum, and so into the seminal vesicles, the angle of introduction being often better through the rectum. The dosage varies with the size of the tumor, but at one time rarely more than 800 mc. hours are given, and generally less. If there is urethral invasion, screened radium (silver ½ mm.) is used in the catheter, the dose being about 200 mc. hours. Bare tubes of radium are not used in the prostate, as they cause undesirable slough and pain.

This completes the treatment in from two to three months. A slow sclerosis of the carcinoma goes on during this period. The patient, instead of having to go through a period of recovery from his radium treatment, which seems to us inevitable, when the larger doses are given, is encouraged to get stronger, to exercise, so stimulating the production of any natural barriers he may have within him. And this last is very far from a theoretical consideration. Many patients, if they live long enough, seem to reach a more or less stable condition, as far as their cancer is concerned, and improve in health and strength. Every two or three months radium treatments are repeated until in cases which react well, the prostate is a sclerosed mass. Such cases, we all know, are only too rare.

Recognizing the low percentage of actual cures by radium or operation of carcinoma of the prostate, it would seem that this gentler and more occasional treatment were better.

2. *Urinary Obstruction in Advanced Cases.*—One of the most interesting problems of prostatic carcinoma is the management of urinary retention in cases in which the growth is extensive. These patients have a short lease of life, at most two or three years, and living may have become intolerable to them, because of the frequent and painful urination, or the impossibility of

* Read before the American Association of Genito-urinary Surgeons, May, 1924.

urinating at all. In such cases a major operation is to be avoided, if possible. Young has employed the Bottini operation in four such cases, with distinct palliation of symptoms. We have employed an even simpler method. The Young punch instrument has been modified, the length of the opening in the instrument made three times the original size. In this way a much larger piece can be punched out of the bladder neck. We routinely make three or four punches of the lower part of the bladder neck. This operation has been used in 13 cases. The average age of patients operated upon was sixty-two years, the oldest seventy-five, and the youngest fifty-two years. Residual urine varied from 60 c.c. to complete retention. In 12 cases the residual urine diminished, and in one case did not. In 4 of the 12 cases the operation reduced the residual, respectively, from 90 c.c., 120 c.c., 120 c.c., 210 c.c., to none. The operation seems to work best where there is complete retention. In 4 such cases the residual fell, in 1 case to nothing; in 1 to 15 c.c., and in 2 to 60 c.c. There were 4 other cases in which the residual was cut in half, but the patients still retained enough urine to cause frequent, and in most cases, painful urination. Therefore, the operation succeeded in 8 of the 13 cases, 61.6 per cent., and failed in 5 of 13 cases, 38.4 per cent. When it does fail, I believe the only thing left is permanent suprapubic drainage.

FIG. 1.—Modified Young punch instrument. The opening in instrument is three times that of original.

Duration of Life After Operation.—One died in 16 days from uræmia; the operation undoubtedly hastened his death. Two died in 5 months, 1 died in 7 months, 1 in 8 months, 1 in 12 months, 1 in 13 months. Six are still living. Four for 5, 9, 13 and 18 months post-operation, and 2 are recent cases.

Pathology.—Of 12 cases the examination of the removed specimen showed carcinoma in 11. In 1, normal prostatic tissue. One of the cases showed an epidermoid carcinoma of the bladder, the primary lesion, with a prostatic carcinoma secondary.

3. *Cure of Prostatic Carcinoma by Radium.*—From October, 1915, to January, 1917, we saw 46 cases of prostatic carcinoma at the Memorial Hospital. In but one of these cases was the carcinoma confined to the prostate. Five of these 46 cases lived more than five years. In none of these 5 cases, when last seen, was there any gross evidence of active carcinoma. Therefore in 11 per cent. of this first series was the carcinoma controlled, and possibly

cured. We see at the Memorial Hospital very few cases in which the carcinoma is confined to the prostate—2 per cent., according to our records. I believe that our later records of possible cure are not quite as good as this first series. It seems conservative to say that with radium treatment from 5 to 10 per cent. of cases of carcinoma of the prostate may be cured.

A short résumé of these five cases is of interest:

Case I.—J. D., age fifty-seven, first seen October 15, 1915, carcinoma of prostate, extending somewhat beyond prostate. Diagnosis with Doctor Keyes. No specimen. Treated only with radium needles, four times, at intervals of about three months each. In perfect health five years and three months after first seen, then lost track of.

Case II.—A. S., age sixty-six, first seen October 10, 1916, prostatectomy by Doctor Keyes. Pathological examination showed carcinoma of low malignancy. Treated only with radium needles three times. Five years later developed urethro-rectal fistula from radium needle; well, before this, seven years after first seen.

Case III.—M. P., age sixty-four, first seen April 2, 1917. Prostatectomy by Doctor Downes, at St. Luke's Hospital, January, 1916. Section showed carcinoma. Seen one year after operation with nearly complete obstruction at bladder neck. Treated only with radium needles in prostate three times and dilatation. Six and a half years later is well, barring ½ to 2 ounces residual urine.

Case IV.—J. H., age fifty-five, first seen July, 1917, hard and irregular carcinoma, left lobe around into left vesicle. Diagnosis with Doctor Keyes. No specimen. Treated twice with radium needles. Well, six years and six months later.

Case V.—J. C., age seventy, first seen February, 1916. Early case, with some question of diagnosis. Diagnosed by Doctor Keyes as carcinoma. Doctor Beer questionable. Later examination because of enlargement around seminal vesicles, and diagnosis seemed to be assured. His first symptom was a complete retention of urine. Treated only with radium needles in prostate twice. Well seven years and nine months after first seen. No recurrence of retention.

4. *Bone Metastases in Carcinoma of the Prostate.*—I have reviewed the radiographs in 44 cases of extensive carcinoma of the prostate. The radiographs taken were as follows:

Lumbar spine, pelvis, upper end femur	39 cases
Lumbar spine, pelvis, upper end femur and dorsal spine	1 case
Lumbar spine, pelvis, upper end femur and chest	2 cases
Lumbar spine, pelvis, upper end femur, dorsal spine and chest	1 case

All bones and chest, 1 case.

Metastases as follows:

No metastases	32 cases,	72.7 per cent.
Metastases	10 cases,	22.7 per cent.
Suggests metastases	2 cases,	4.5 per cent.

This percentage of metastases very well agrees with Bumpus's figures.

Situation of metastases:

Lumbar spine and pelvis	10 cases
Dorsal spine	1 case
Hilum lungs and lumbo-sacral spine	1 case

In most of the cases the metastasis was of the sclerosing hyperplastic or productive type, so different from that so often seen, in bladder carcinoma, the rarifying type. In 11 cases there was shown hypertrophic, osteo-arthritis. In 2 of these 11 cases the carcinomatous metastases were shown.

It is our routine at the Memorial Hospital to take a radiograph of the lumbo-sacral spine, pelvis, and upper femur, unless there is a special indication to take other regions. This, as a rule, will show the metastases, if they be present. On the other hand, in one of the above cases the metastatic growth was in the fifth dorsal vertebra alone. In this case we should have missed it without the radiograph.

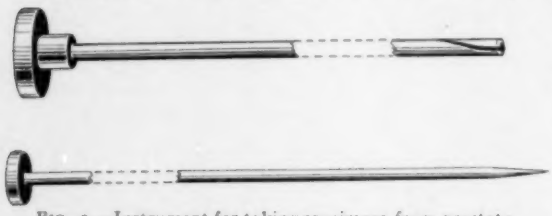

FIG. 2.—Instrument for taking specimens from prostate. Diameter of shaft 3 mm. (.113 in.)

5. *Diagnostic Needle.*—The original needle used at the Memorial Hospital is somewhat smaller than the one now used. If the present needle is well taken care of, and is sharp, we can get a specimen of the prostate in practically every case. The needle is routinely used in cases in which the diagnosis is in question. It has been of value not only in diagnosing carcinoma, but in differentiating tuberculosis of the prostate from simple prostatitis. Recently we have had two cases in neither of which did I believe carcinoma to be present. I was simply suspicious that it might be. With the diagnostic needle, a specimen was obtained and a diagnosis of carcinoma was made in both cases. These are the two earliest cases we have seen in six months.

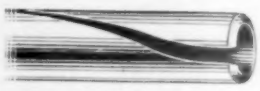

FIG. 3.—Enlarged cutting end of Fig. 2. Cutting edge must be kept keen.

Summary.—The best method of treatment in our hands has been by radium needles inserted into the prostate and seminal vesicles, this repeated every two or three months until sclerosis of the carcinoma occurs. If there is urethral invasion, urethral treatment is added, to the needle treatment. The modified punch operation has been used in 13 cases of extensive prostatic carcinoma to overcome urinary retention. It was used successfully in 61.6 per cent. cases, and failed in 38.4 per cent. Five cases out of the first 46 seen have gone more than five years with the carcinoma apparently under complete control. All of these cases were treated solely by radium needles.

In from 5 to 10 per cent. of cases, the carcinoma ought to be controlled by radium. Bone metastases occur in our cases in 27 per cent.

The diagnostic needle developed at the Memorial Hospital enables us to make an accurate diagnosis in a much larger percentage of early cases, and is used routinely in the diagnoses in question.

THE INDICATIONS FOR OPERATION IN THE TREATMENT OF TUBERCULOUS CERVICAL LYMPH GLANDS*

A PRELIMINARY REPORT

By John M. Hanford, M.D.
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Amongst a large number of clinicians both here and abroad, reaction against surgery places on the defensive, the advocate of operation for tuberculous glands. On the continent of Europe, non-operative treatment (other than the use of an aspirating needle) is decidedly in favor. This influence has been largely responsible for the present conservative attitude toward the disease in America. The use of X-ray therapy, the systematic application of sunlight, the importance of eradicating foci of secondary infection, like the teeth and the tonsils, and indeed in this country, the feeling that tuberculosis is on the wane, have been strong factors in the decline of radical surgery.

A few years ago, medical students were quite generally taught that the standardized treatment for tuberculous glands of the neck was radical excision. The surgical wards of our hospitals then bore evidence of the weight of this teaching. The problem was then simple because it was standardized. Statistics were available on the operative results so that we knew about what to expect from operation. Coincident with the gradual abandonment of radical surgery by large numbers of the profession, the standardized treatment has disintegrated. A generally accepted standard does not exist. The disease to-day is treated by numerous methods—here by one method and there by another—and often with brilliant results; yet this individuality of method, in distant geographical points, has tended to confuse our minds in outlining the treatment of a given patient.

Tuberculosis of the cervical glands in itself is not a serious disease. It is often a self-limited disease. The chief complaint of the patient is either the deformity of a swelling, or the annoyance of a persistent sinus. The aim of treatment is a good cosmetic result which shall be permanent.

Seven years ago this month, in October, 1917, a special study of tuberculous glands was undertaken at the Presbyterian Hospital, New York. During this period over three hundred patients with the disease have been examined and treated; and most of them have been followed. The diagnosis of tuberculosis has been proven in the majority of the patients, while in the others it has been accepted only on satisfactory clinical evidence. The work has been limited almost exclusively to New York City people of small means, and represents an attempt to help them, with the opportunities available, to their greatest economic advantage. The problem would be easier and the results, better were it undertaken where air and sun are ideal as in the Swiss Alps, on a favorable seacoast, or in Southern Arizona.

* Read before the New York Surgical Society, October 8, 1924.

During the first five years, we concentrated upon the effects of repeated small doses of filtered X-ray—a popular method of conservative treatment. From this X-ray part of the study we have drawn certain definite conclusions.

During the past two years, we have enlarged the scope of treatment hoping to raise the percentages of success over the results with the X-ray treatment. We now do everything we can for the patients, including selected operations.

This article deals with the operative indications and we hope that a report upon this part of our present working plan may help to formulate a general standard of treatment.

Let us for a moment first briefly examine some of the observations made after analyzing the X-ray results. These have been reported before the Saranac Lake Medical Society, but not yet published. The method of analyzing the main results was twofold: first, the results in the patients as a group, irrespective of their detailed neck pathology; and secondly, the results in various types of tuberculous neck lesions.

The five main types of lesions were classified as follows:

1. Enlarged firm swellings of less than 2 cm. in diameter.
2. Enlarged firm swellings of 2 cm. or more in diameter.
3. Cystic, or faintly fluctuating swellings.
4. Definitely fluctuating swellings—cold abscesses.
5. Sinuses.

It was found, taking the group of 141 patients, as a whole, treated with relatively frequent small doses of filtered X-ray, that 70 per cent. of these patients showed either apparent cure or such marked improvement as to justify conservative treatment. Thirty per cent. were failures. The results with the five main types of lesions were as follows: Conservative (X-ray) treatment appeared satisfactory in 78 per cent. of the small sized, firm swellings; in 72 per cent. of the large sized firm swellings; in 40 per cent. of the cystic swellings; in none of the cold abscesses as such; and in 76 per cent. of the sinuses. Eighty-five per cent. of the patients were followed after the last X-ray treatment for periods from a few months to four and one-half years.

Thus the small sized swellings and the sinuses responded best to conservative treatment. Some of the cystic swellings did resolve, but most of them became cold abscesses. The cold abscesses either opened spontaneously or were incised when spontaneous opening appeared to be inevitable. It must be stated that besides X-ray treatment these patients received personal supervision of their general hygiene, attention to possible foci of infection, cod-liver oil and whatever simple aid seemed advisable in ambulatory, New York City patients. Sunlight, artificial light, systematized rest, tuberculin, life in the open air and operation were not used to any significant extent.

Combined treatment appeals to us as better than X-ray treatment alone. We are trying to determine the indications for the different therapeutic methods, particularly for operation.

A number of different elemental points are to be considered in deciding questions of operation in a given case. They are (1) the anatomy and (2) the pathology of the neck, (3) general considerations of the patient, and (4) the operative procedures available.

I. *The Anatomy of the Neck.*—This is discussed under two headings, the regions involved by the diseased glands and the important structures which may be damaged by operation. There are fourteen important regions of lymph-gland disease (Fig. 1): 1. The parotid or preauricular region containing both superficial and deep glands, both of which are frequently involved. 2. The facial or supramaxillary region, rarely involved. 3. The submental and suprahyoid, the glands in which are most commonly involved with the anterior submaxillary lymph-glands. Region 4 includes the anterior, middle and posterior submaxillary lymph-glands. These are frequently involved, both singly and conjointly. Region 5 is the commonest location of all for tuberculous glands and is also usually the earliest. It includes most of the upper deep cervical (upper jugular) glands with the so-called tonsillar gland, better termed the "subangular" gland, below the angle of the jaw. Region 6 lies beneath the upper part of the sterno-mastoid muscle and contains the highest of the upper deep cervical group. Regions 7 and 8, include the more isolated, posterior auricular and suboccipital glands which are, like the chain in the posterior triangle, all relatively superficial as in regions 9 and 12. Regions 10 and 11 contain the lower deep cervical glands lying along the internal jugular vein. A high percentage of the supraclavicular enlargements (region 13) in tuberculosis belongs to these lower deep cervical glands which have enlarged backward. The involvement of the axillary glands (region 14) is conceived of as the extension simply to another group of cervical glands, except in such patients as have tuberculosis of the upper limb, the

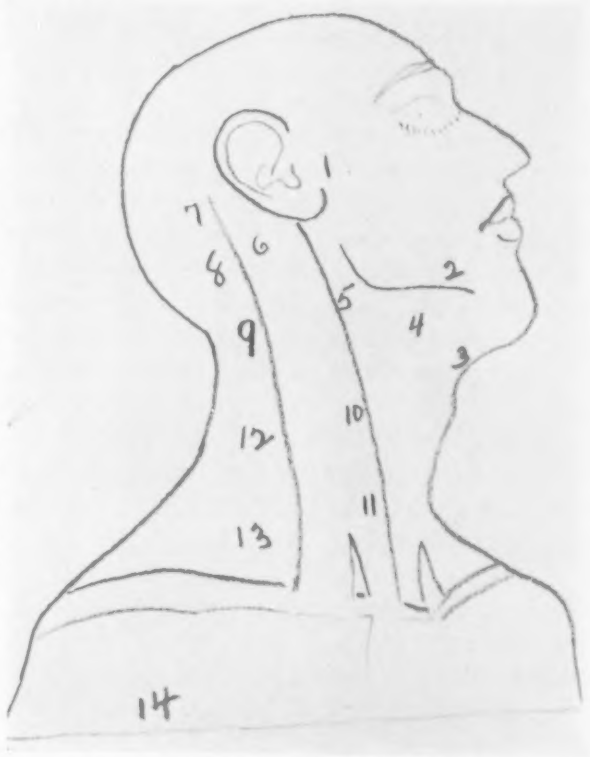

FIG. 1.—The main regions of the neck (with the axilla) involved in tuberculosis of the lymph-glands.

chest wall or the breast. Tuberculous glands are rarely adherent to the axillary vein, so that their removal is not commonly attended by risk to adjacent structures.

The Six Important Neck Structures.—1. The main branches of the facial nerve are not exposed to damage by operations in this disease except in the parotid or preauricular region (1).

2. The submaxillary branch of the facial nerve supplying the muscles of the lower lip as Farr[1] has demonstrated, lies beneath the superficial layer of the deep fascia running well below the body of the lower jaw. It is exposed to damage in regions 4 and 5.

3. The spinal accessory nerve lies deeply placed beneath the upper part of the sterno-mastoid, and is exposed to damage in regions 5 and 6. Particularly in region 6 is it in danger, because it may become adherent to the enlarged overlying nodes. It is then often difficult to identify. When cut or damaged in this region both sterno-mastoid and trapezius muscles are paralyzed, occasionally with a distressing result. Apparently the nerve need not be divided to cause the paralysis. Trauma and subsequent fibrosis may do so. In regions 9 and 12 the accessory nerve again becomes susceptible to injury in its path from the sterno-mastoid to the trapezius.

4. The internal jugular vein must be protected in its whole extent in order to avoid troublesome bleeding. In region 11, where the vein is less easily accessible (unless the muscle be cut), and also less easily mobilized and retracted, bleeding may indeed be dangerous.

5. The subclavian vein is exposed to damage in regions 11 and 13, where enlarged glands tend to extend backward beneath the muscle becoming adherent not only to the internal jugular vein, but also to the subclavian. Bleeding from this vein may prove serious.

6. In regions 11 and 13, too, the thoracic duct may inadvertently be divided or opened.

Aching shoulder is occasionally seen following a simple biopsy in the posterior triangle when the accessory nerve is thought to have escaped injury. The cause of this is not known. One theory is that it is due in some way to division of the descending cutaneous branches of the cervical plexus. Temporary numbness of the face, ear and neck following division of the upper cutaneous branches of the cervical plexus usually is inevitable and of only slight importance.

In certain parts of the neck there are features that appear to favor resolution without excision. It is noticed, for example, in the supraclavicular region (13) that conservative treatment is more successful than in region 5. The glands in region 13 are by nature almost completely immobilized; they are protected by the clothing from handling and from cold; they are far removed from the common foci of infection above. Conservative (non-operative) treatment here, therefore, is justified because it is more successful, because from the cosmetic viewpoint it is less imperative and because excision

endangers important structures. The constant motion of the axilla, however, militates against resolution here (region 14).

II. *The Pathology of the Neck.*—In a previous paper[1] attention was called to the applied pathology of the disease. Mention has already been made of the five main types of lesions. Since then a sixth type, "diffuse, firm swelling" has been added, so that now the list is as follows: 1. Enlarged, firm glands of less than 2 cm. in diameter. 2. Enlarged, firm glands of 2 cm. or more. 3. Diffuse, firm swelling. 4. Cystic or faintly fluctuating swellings. 5. Cold abscesses or definitely fluctuating swellings. 6. Sinuses.

FIG. 2.—A schematic representation of the three groups of Dowd. Group 3 includes Groups 1 and 2.

The smaller glands have a better prognosis than the larger ones with conservative treatment. Diffuse, firm swelling is rarely suitable for operative treatment. The cystic swellings are separated because they have a fair chance of resolution without softening, under conservative treatment, whereas a more definitely fluctuating lesion, a cold abscess, has very small chance of resolution, without sinus formation. These various types of lesions may occur singly or may occur in any number of combinations in two or more of the fourteen main regions.

Dowd,[3] in 1916, treated the working pathology by describing three groups of cases. These are explained best in the diagram (Fig. 2). His "group 1" corresponds to any of our first five types if located in region 5. "Group 2" corresponds to group 1 which has developed a sinus, or to group 1 which has extended into our regions 6, 8, 9, 10 and 12, with any of our first five types of lesions. "Group 3" includes those patients with extensive cervical tuberculosis having any of our types of lesions and usually with evidences of tuberculosis in other parts of the body. The neck infection in group 3 involves a great number of nodes and displays all types of lesions.

An analysis of the neck pathology must be made in every patient before outlining the plan of treatment. As the course progresses this plan of treatment is always open to change dependent upon the variations in the neck

pathology. The operative indications may be quite different after the period of conservative treatment from what they were at the start. X-ray therapy, for example, tends to disperse a diffuse, firm swelling and to isolate localized swellings suitable for excision. We have found that X-ray therapy does not appear to increase the difficulty of the simple excisions used in our plan of treatment. An abscess may be incised in one stage of treatment and later, the remaining lesion (perhaps a sinus or a small firm mass), may be suitable for excision. If we discount general considerations we always have certain definite local findings capable of analysis for the outline of treatment. These local findings are based upon the six main types of lesions and upon the fourteen main regions. We may also have to reckon with such questions as the removal of an old scar and the extent of coincident pyogenic infections. With all this knowledge, then, at hand, there is some approach to a formula for operative treatment.

III. *General Points Relating to the Patient.*—Age. A common conception of tuberculosis is that of infection in early childhood, of distribution manifested in later childhood, and of extension or of recrudescence in later years in parts previously invaded during the stages of infection and of distribution. Broadly speaking, the forces of resistance increase with age. To operate upon a tuberculous lesion in a child under five years of age predisposes that child to distribution, the most striking example of which is tuberculous meningitis. It may be safe to make this rule, therefore, that with a child under five, the only operations permitted are the simpler ones of aspiration and of simple incision of cold abscesses and perhaps occasionally of gentle curettage.

Race. It has seemed to us that the Negro and the Chinese in our series have relatively low resistance or a relatively high state of hypersensitiveness, or both, and that with them at all ages, greater caution is needed in operating upon tuberculous lesions for fear of inducing distribution or extension and recrudescence elsewhere.

The forces of resistance. Besides age and race, the signs of good nutrition and good health are the important ones. Resistance should reach its maximum at the end of the period during which all the well-known and accepted methods of conservative treatment have been employed. This, then, is undoubtedly the safest time for operation. But practically in the majority of cases, operation is indicated in a much earlier stage of the treatment period, usually indeed at the very start, as we shall soon see.

Active tuberculosis elsewhere than the neck or axilla. As a general rule, the non-cervical tuberculosis takes precedence so that the whole plan of treatment depends upon the needs of the more important lesions. The commonest one, of course, is pulmonary tuberculosis. This main principle usually may be followed, that only operations of the simpler class are indicated upon the neck in patients with active disease within the chest or abdomen. More radical steps occasionally may be taken in the neck in the case of coincident external lesions in patients over seven or eight years of age.

Hypersensitiveness. In patients with tuberculosis of the neck, a state of hypersensitiveness may exist in the presence of any of the following conditions: (1) Fever, whether due to active tuberculosis anywhere in the body or due to pyogenic or other infections in the neck or elsewhere. (2) Active tuberculosis elsewhere than the neck even without fever. (3) Within two months of a definite tuberculin reaction, as from too large a dose in treatment. (4) Within two months of an operation of the more extensive class upon tuberculous tissue anywhere in the body. (5) Within two months of a definite reaction of a large dose of X-ray treatment which possibly acts like an overdose of tuberculin. These are largely theoretical, but nevertheless worthy of thought in deciding questions of operation upon tuberculous tissue.

While tuberculosis in the neck is not a serious disease, there is almost certainly some degree of intoxication exerting variable effects upon the general health and upon the heart, the liver, and the kidney.

The condition of possible foci of infection draining into the cervical lymphatics. The tonsils—shall they be removed before, during, or after an operation upon the neck? It is impossible to make rules covering all cases. There are two or three points of interest. It is probably unwise to let anything take precedence over the excision of a suitable neck lesion partly softened. On the other hand, it is gratifying to feel that the infection of the cervical glands by the operations upon the upper diseased foci has run its course and done its work before we attack the disease in the neck. Let the tonsillectomy, the tooth extraction, the radical mastoidectomy have their utmost effects upon the neck lymphatics before the final neck operation be planned. If the tonsils or adenoids prove to be tuberculous, it is probably safer to postpone the neck operation two months after their removal. They should always be examined after removal. With general anæsthesia it is usually advisable to do the simpler operations upon the neck under the same anæsthesia used for the operation upon the upper foci of infection; but for the extensive excisions in regions 4, 5, 10 and 14 (Fig. 1), the neck operation should be done at a separate time—afterwards if there is no softening beforehand.

The patient's choice. From our conclusions of the study of conservative treatment the chances of recovery without operation for different types of the disease can be estimated with an approach to accuracy. These, together with the operative statistics of Dowd,[3] give a good basis from which to conclude that careful excisions plus the conservative (non-operative) methods of treatment give better results in most of the early cases than does the conservative treatment alone. By better results we imply the main objects of treatment—safety, permanence, speed and appearance. The patient or the guardian must be given the information that no known plan of treatment can insure a cure; that recurrence may at any time appear no matter what be done; that complete excision in a given region may be followed immediately by new local or distant neck swellings; that operations of the more extensive class may inadvertently cause nerve damage; that well-planned incisions may

end in keloidal scars; and that after operation definite treatment and supervision are advisable over many months' time. The scars of the different types of operation must often be compared with each other and they must also be compared with the scars of existing sinuses and of spontaneous openings. Though operation be decided against at one time, the question should always be left open for the future. If operative scars be dreaded, reassurance can be given in the favorable effects upon them of the X-ray and light treatments.

IV. *The Available Operative Procedures.*—There are seven; and they are discussed in the order of their probable value as an aid to cure.

1. Complete excision of a lesion or of a group of lesions. Excision of a tuberculous lesion in any part of the body is the best method we have to attain a positive cure. The limitation to conservative treatment in pulmonary tuberculosis is after all but a makeshift because excision is impracticable. We can never be sure of having achieved a complete excision because of the uncertainty of involvement of surrounding or adjacent lymphatics; but no combination of conservative methods of treatment can assure destruction or permanent quiescence of tubercle bacilli.

Complete excision is the most fundamental part of treatment from the standpoint of cure. Excision is more likely to be complete if done before liquefaction-necrosis has thinned out the boundaries of the affected parts, and it is also more likely to result in a good cosmetic result, a clean linear scar. Therefore in the locations where complete excision is permitted this is the operative indication, and especially so with the large sized glands. But if liquefaction be detected the case at once becomes a surgical emergency so that excision shall precede the thinning out of the boundaries. This applies to the small as well as to the large glands. A few days delay will often entirely alter the favorable prospects of cure and of the linear scar. The detection of fluctuation, therefore, in an excisable region, indicates the need of excision within forty-eight hours as a general rule. If the patient be first seen when the skin is already thinned out, the same urgent need of early operation is demanded, so that whatever operation be selected it shall precede spontaneous rupture, with the consequent inevitable contamination of the part by secondary infection. Thus in the regions favorable for excision, we have two types of lesions calling for expedition in their operative treatment, cystic swellings and cold abscesses. They should not be kept waiting for a convenient time nor for an empty bed in a hospital. They need the considerations of an emergency.

The best follow-up results discovered for any method of treatment of tuberculous cervical glands are those of the large series of Dowd,[3] with whom 91 per cent. of patients in group 1 remained cured after excision. The keynotes to his success were early diagnosis in the early stage with early complete excision. If we add to excision in selected cases the conservative forms of treatment, may we not be approaching an ideal for our generation? Complete excision, however, is limited to certain regions of the neck for one main reason, namely, because endangering the important neck structures is not

justifiable in the face of the favorable results obtained by more conservative treatment.

A "bloc-dissection" of the neck for this disease is by this token alone never justifiable. Moreover, one can never foretell that such an extensive procedure will not be too great a drain upon the patient's resistance.

2. Excision of a part of the disease in a given region. This may be permitted at times provided the line of excision does not traverse gross tuberculous tissue. For example, it seems occasionally preferable to leave inaccessible glands during an attempted complete excision than to endanger important structures. The impression is that the removal of the bulk of the disease in a part favors the subsequent healing of the remainder. It is not ideal but it is safe, and when combined with the other forms of treatment offers a good prospect of cure. Procedures 1 and 2 are applicable to any type of lesion in any of the regions suitable for excision, provided the cleavage plane remains outside of the gross disease. The two main reasons for not keeping the cleavage plane outside of the gross disease are the dangers to important structures and the possible magnitude of the procedure. It is said that incomplete excision leads but to a persistent sinus. The reply to this is that 76 per cent. of our sinuses healed with conservative treatment.

3. Partial excision with curettage. The use of this procedure implies the presence of necrosis to the extent that the cleavage plane of an excision cannot be kept outside of the gross disease. Curettage is then substituted in part for excision.

4. Incision with curettage. Excision of a cold abscess is always preferable to curettage, as an ideal procedure. But if a cold abscess be too extensive or if the boundaries be too friable; if it lies in a region unsuitable for excision; if the skin be too extensively thinned out, then curettage through a small incision provides a safe method of removing the bulk of the disease with a minimum of risk and scar. Curettage may be practiced with varying degrees of gentleness and thoroughness depending upon the local and general conditions. A cold abscess often consists of a double or of a triple cavity formation wherein the superficial cavity signalizes deep-seated disease. Thorough curettage reaches all of the cavities, and if necrotic material be well removed, it may facilitate the ultimate healing, but blind force in reaching inaccessible pockets is to be avoided.

5. Incision. Incision alone without curettage is the simplest operative procedure next to aspiration. It is applicable only to the cold abscesses. Incision alone is indicated in the larger abscesses, especially in young children and in patients who may be hypersensitive to the toxins of tuberculosis. It is satisfactorily done with local anæsthesia whereas curettage usually requires nerve blocking or general anæsthesia.

6. Aspiration. Aspiration has been a disappointment in our series of patients. Like simple incision it is limited to fluctuating lesions. Experience has led to the following conclusions:

a. It is safe and it leaves no scar. b. There are no positive contra-indications to it *per se*. c. It may turn the tide toward resolution of cystic swellings and of cold abscesses during the course of conservative treatment. d. If successful, it is less likely to involve the skin and to leave a sinus than is incision. e. It does not so completely empty the cavity as does incision and by no means so completely as incision with curettage. f. Usually it must be repeated one or more times—more frequently than incision. g. Even when successfully carried out it usually fails to effect the resolution of a cold abscess. h. When it does result in apparent resolution, local recurrence is more frequent than with any of the other operative procedures for softened lesions. i. It is more distressing than simple incision because so much pressure is needed even with a nick in the skin to introduce a large needle at a distance from the involved skin. Success is mainly dependent upon a large needle. j. It fails in those lesions which though fluctuating are not fluid, whereas, through a small incision much of the soft necrotic material can be evacuated by light pressure.

7. Injections and aspiration.[4] The rationale of this practice is that by inducing liquefaction the disease can be aspirated away, giving a cure without a scar. It facilitates one of nature's methods of cure by softening and extrusion. Our studies have not included a trial of this plan of operative treatment so that no final opinion is justifiable. Since it aims at the production of a cold abscess and since our success with the aspiration of cold abscesses has been slight, it does not impress us favorably. It appeals to one as an indirect slow method of incomplete removal. There probably are, however, indications for its use if carefully studied.

The seven operative procedures are divisible into two classes, those which tend to induce distribution and hypersensitiveness and those which do not. In the first class are the three kinds of excision and the thorough curettage; in the second class, the simple incision (perhaps with gentle curettage) and aspiration. They are called respectively the "more extensive" and the "simpler" operations, because of the difference in degree to which they tend to open the lymphatic and the blood-vessels in the diseased region.

If a biopsy be needed to establish the diagnosis, it should be made therapeutic also if feasible.

With a knowledge of the normal anatomy and keeping in mind all the general considerations relating to the patients, it is possible to try to determine what operations are suitable for the different types of lesions in every one of the several regions.

Region 1—parotid. Conservative treatment appears to have a high percentage of success in the firm and cystic swellings. Excision is rarely indicated because of danger to the facial nerve. Incision with curettage (Fig. 3, 1A), simple incision (Fig. 3, 1B) and aspiration are suitable for abscesses.

Region 2—facial. Little experience with this region, on account of its rarity of involvement, justifies impressions only. The firm swelling rarely

becomes large so that a positive diagnosis is not usually made until softening has occurred, in which case the choice of excision or of one of the less complete operations in each case must be decided. There are no important structures to be damaged but the cosmetic result is important. (Fig. 3, 2).

Region 3—submental. Here there are no structures endangered by radical removal by the best method feasible of any type of lesion, the earlier the better. (Fig. 3, 3.) As a rule, however, the submaxillary lymph-glands (region 4) of one or both sides are simultaneously involved, in which case region 3 may be viewed as an operative part of region 4.

FIG. 3.—The common incisions.

Region 4—submaxillary. The submaxillary branch of the facial nerve to the muscles of the lower lip runs below the margin of the lower jaw beneath the superficial layer of the deep fascia.[2] A low incision is necessary to avoid cutting it. (Fig. 3, 4.) Excision of the firm and cystic swellings is done through a low incision without permanent damage to the nerve. It does become temporarily paralyzed, often due, perhaps, to traction upon the upper flap in which it lies. Permanent paralysis is an unfortunate disfigurement and should be avoided. It is seen most frequently after operations upon abscesses and sinuses when the nerve has become implicated, before operation, in the skin involvement. In these cases, a low incision is made and a partial excision with curettage is done. The upper flap is gently handled and its under surface lightly curetted with gauze. If permanent paralysis already exists, from a previous operation, then the nerve is disregarded and attempted complete excision is done.

Region 5—subangular. This is the region par excellence for a complete excision of any type of lesion. If the skin be extensively involved or the deep boundaries thinned out, partial excision with curettage may have to suffice. If the adjacent region 6 be conjointly diseased, excision only of that part of the disease in region 5 is done. Dowd says that "very few patients who have thorough operation when in group 1 ever reach group 2." We would reëmphasize the importance of immediate complete excision of all types of lesions limited to this region. The operation is safe; the scar is minimal; and the end results quoted above are highly satisfactory. If the disease be

limited to region 5 the spinal accessory nerve is usually spared with care. In region 5, a low incision is needed to avoid the nerve to the lower lip as in region 4. (Fig. 3, 4 and 5.)

Region 6—deep submastoid. Only the simpler operations are done in region 6. The spinal accessory nerve is spared at any cost. Complete excision is never attempted.

Regions 7 and 8—posterior auricular and suboccipital. The glands here are rarely tuberculous, but if the diagnosis be made before softening occurs, excision is indicated. The regions are safe so that attempted complete removal of any type of lesion is justifiable. (Fig. 3, 7 and 8.)

Regions 9 and 12—the middle part of the posterior, superficial chain of glands. The spinal accessory nerve traverses these regions. Isolated firm and cystic swellings are excisable with care, but the abscess should be subjected merely to the simpler operations. Sinuses may be curetted but their complete excision is hazardous. Paralysis of the trapezius causes aching, deformity and loss of function. (Fig. 3, 9 and 12.)

Regions 10 and 11—the lower deep cervical. In the upper part of this group of glands, in region 10, complete excision is indicated for circumscribed, firm and cystic swellings, abscesses and sinuses, provided there is no involvement below in region 11. Regions 5 and 10, if both are involved, are suitable for a single, complete excision of the whole mass; but if region 11 be involved with region 10, excision of part of the disease may be done, leaving the disease in region 11. Region 11 is dangerous because the disease here tends not only to adhere to the fixed lower part of the internal jugular vein, but also to extend backward beneath the muscle into region 13, becoming adherent to the subclavian vein and to the thoracic duct. Hence only the simpler procedures are indicated in regions 11 and 13. Fortunately their prognosis with non-operative treatment is relatively good. (Fig. 3, 10, 11 and 13.)

Region 14—the axillary glands. Complete excision is indicated with any or all types of lesions in the axilla unless there is the unusual condition of adhesions to the vein or to the plexus. In this case excision of part of the disease is done or, partial excision with curettage. (Fig. 3, 14.)

CONCLUSIONS

1. Operation is indicated in a large number of patients with tuberculous cervical lymph-glands.

2. It is impossible to make rules covering all the combinations of lesions and regions which may be seen in patients with more or less extensive involvement. An adaption of the main principles is worked out for every patient. Early removal of all tuberculous tissue is the ideal; but it must be tempered with an eye to the ultimate appearance of the neck and with safety to the patient and to the important structures. After time and conservative treatment have done their work, a later removal, if needed, is always worthy of consideration.

3. The results with conservative treatment (including the simpler operations) are so good that only those radical operations are done which are relatively easy and devoid of nerve and vein damage.

4. The more extensive operations are relatively safe in regions 3, 4, 5, 7, 8, 10 and 14.

5. Damage to the nerve to the lower lip is surprisingly frequent in regions 4 and 5.

6. Damage to the accessory nerve is not infrequent in region 5.

7. In Dowd's group 1 (region 5) early complete excision is recommended.

8. In his group 2 (regions 5, 6, 8, 9, 10 and 12) complete excision of the whole mass of disease is replaced by the safer but less ideal procedures as needed according to the lesions.

9. In his group 3 (scattered regions) the same attitude is held as for group 2.

10. Operative procedures are but a part of the whole plan of treatment and may be indicated at any period, depending upon the general and the local conditions.

11. The general and the local conditions are capable of definite analysis.

This preliminary report is presented with the expectation that from its criticism our ideas about operation will become more clear cut and better directed in the continuation of the attempt to standardize the treatment as a whole.

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RUPTURE OF THE DIAPHRAGM *

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If one includes in his definition of hernia only those protrusions from the peritoneal cavity which are covered by a true sac, then the occurrence of diaphragmatic hernia is rather rare. In this paper we shall give to the term *hernia* a broader significance, and include under diaphragmatic hernia both the cases of true hernia where there is a peritoneal sac, and also those cases in which there is an open communication between the abdominal and thoracic cavities through a defect in the diaphragm.

Diaphragmatic hernia in both the traumatic and congenital forms is a condition that has been recognized by surgeons and pathologists for a very long time. But the surgical treatment of the condition is a recent development. The following statement is made in Holmes' "System of Surgery," published in 1881: "We are silent on the subject of treatment. We cannot hope to close the aperture in the diaphragm by any measures which science or mechanical surgery would justify; could we accurately detect the existence of a protrusion it were in vain to attempt its reduction with any benefit to the patient or credit to ourselves."

Unsuccessful attempts to cure diaphragmatic hernia by operation were made by Naumann in 1888 and O'Dwyer in 1889. Naumann's case was strangulated and occurred in a nineteen-year-old workman. He operated through a laparotomy incision. The patient died the same day. O'Dwyer's case was that of a congenital hernia in a child. His pre-operative diagnosis was empyema. The operation demonstrated the nature of his mistake. A subsequent attempt to repair the hernia was unsuccessful and the patient died.

The first successfully operated case of diaphragmatic hernia was that of Postemski in 1889. A boy, fourteen years old, received a stab wound in the left lower thorax, following which a piece of omentum protruded. Thoracotomy was performed, the diaphragm sutured through the thoracic incision, and the patient recovered.

Following this Farinato in 1895 reported a case of strangulated hernia following a stab wound ten months previously, upon which he had successfully operated. In the same year Llobet reported a successfully operated non-strangulated case which followed a stab wound eleven months previously. This case came to operation because of the appearance of a swelling in the eighth intercostal space. The operation disclosed the fact that this swelling contained omentum.

In 1906, Wieting in an interesting publication of what he called the

* Read before the Clinical Club of Baltimore, January 3, 1924.

"chronic form" of diaphragmatic hernia had the following to say: "There exist very few cases of this nature diagnosed during life; and, if one makes an exception of the case of Llobet, because the hernia made its appearance at the exterior, the case of Heidenhain will be very probably the first case of congenital hernia diagnosed and operated with good results; and mine the first of hernia of traumatic origin which was diagnosed accurately before having been cured by surgical intervention." However, Cranwell accurately diagnosed and successfully operated upon a case of this "chronic" variety in 1906 before reading Wieting's paper, but the case was not published until 1908. Heidenhain's case was reported in 1905. Since then the number of cases have been gradually increasing with each succeeding year.

As a matter of fact the number of cases of diaphragmatic hernia in the medical literature is rather large, although very few of those reported were diagnosed during life. From the clinical records one would be led to believe that the condition is very rare. The pathologists, however, give us a slightly different view of the matter. Lacher in 1880 collected two hundred and sixty-six cases from the literature and arranged them in tabular form. He also reported three cases of his own. Struppler, in 1901, collected five hundred cases from the literature. Giffen, in 1912, increased this number to six hundred and fifty. Scudder, in the same year, wrote upon the subject and stated that there were "about 1000 cases recorded," a large portion of which were discovered at autopsy. One gets the idea from going over the subject in the Index Medicus that the number of reported cases has increased more rapidly since the date of these two papers. The influence of the World War with its large number of traumatic cases has given some stimulus to the subject. Most of the cases reported, however, are congenital hernias of babes or symptomless hernias discovered at autopsy. Of Giffen's six hundred and fifty cases only 15 were diagnosed correctly during life. Scudder's series contained 53 cases that had been operated upon, but of these only six were diagnosed before operation. In 1919, Frank could add only 41 cases to the operative series, while Truesdale in 1921 reported 96 cases that had been operated upon in the years 1918 to 1920. Forty-three of Truesdale's cases were the result of battle casualties. This brings the total number of operative cases reported in 1921 up to 190. However, it is probable that some cases were duplicated in Frank's and Truesdale's series, due to the overlapping of the periods they covered. This would make the total figure somewhat less than 190. But there must have been a number of cases operated upon during the war which were not reported.

The mortality in Scudder's series was 75 per cent. This high mortality rate was due to the fact that most of the cases were operated upon for intestinal obstruction and at operation strangulated bowel was found. According to Truesdale, the present mortality rate in non-strangulated cases is less than 10 per cent. The discrepancy between the total number of operative cases and the number diagnosed before operation would indicate that the

mortality rate might be even further reduced if more attention were paid to an early diagnosis.

Only 10 per cent. of diaphragmatic hernias have a sac. The other 90 per cent. are of the false variety—hernia diaphragmatica spuria—in which the herniated organs lie naked in the pleural cavity.

Diaphragmatic hernias are as a rule either congenital or traumatic. However, perforation of the diaphragm may be due to inflammatory process of the digestive tract, gastric or duodenal ulcer, rupture of a subphrenic abscess, empyema, or carcinoma. All congenital hernias are not present at birth, but there is always a congenital weak spot at which point the hernia may later appear. The total number of the latter type probably constitutes a very small percentage of the whole. It is quite likely that all of those hernias which have a sac belong to this group. In the rare condition known as eventration of the diaphragm, in which one entire half of the diaphragm is thinned out, weakened, and displaced upward by the abdominal viscera, we are probably dealing with a congenital weakness of a large portion of the structure. The number of congenital defects of the diaphragm in which part of the abdominal viscera lie free in the pleural cavity is quite large, and these cases often cause no symptoms whatsoever.

The traumatic variety is the one that most interests clinicians as it represents the type in which the clinical diagnosis is most often made, and is also the type in which operative interference is most often necessary. Diaphragmatic hernias of all types occur on the left side in 92 per cent. of the cases, and on the right side in only 8 per cent. There are several reasons for this. In the first place it is quite probable that the liver acts as a buffer and protects the right side of the diaphragm from the impact of the other abdominal viscera. Another factor is the unique fact that stab wounds and gunshot wounds occur more commonly on the left side. This might be explained by assuming that the person inflicting these wounds aims for the heart of his victim. In the case of stab wounds it is quite probable that they occur most frequently on the left side because that is the location in which they could be most conveniently dealt by the thrust of a right-handed assailant. Finally, there are developmental reasons for the more frequent occurrence of diaphragmatic hernia on the left side. Von Bergmann's "System of Practical Surgery" † treats the development of the diaphragm as follows: "According to Hertwig, the chest cavity and pericardial cavity begin to separate from the abdominal cavity by a transverse fold developing from the anterior and lateral wall of the trunk and presenting a free edge in the centre and behind. This is called the septum transversum. After the pericardial cavity has been separated from the pleural cavities by the pleuropericardial folds, other folds develop from the posterior walls of the trunk that unite with the septum transversum and form the posterior portion of the diaphragm. The diaphragm therefore consists of an old ventral portion and a more recent dorsal

† Volume ii, p. 555.

portion. The final condition of the diaphragm is produced by the muscles of the trunk extending inward between the connective-tissue folds. When the dorsal and ventral portions do not become united on one side, a diaphragmatic opening remains which represents a communication between the chest and abdominal cavity." Bayne-Jones, in his interesting article on eventration of the diaphragm, has the following to say upon the subject: "On the right, the liver, growing in the septum transversum, which early separates the pleural and peritoneal cavities on that side, seems to guard the right side of the diaphragm from developmental disturbances. The left side, however, grows in close association with the left lobe of the liver, the stomach and spleen, the pericardial formation, one of the pulmonary ridges, and the pleuroperitoneal membrane. In addition, the posterior portion of the left side of the diaphragm is the last to close." The reason then is clear as to why developmental defects occur more frequently on the left side.‡

Even where the different muscular portions have met there are not infrequently small gaps left closed only by peritoneum and pleura. One of these is constant in front between the costal and sternal portions of the diaphragm, and is known as the foramen of Morgagni. There is also another one behind, between the costal and lumbar portions, known as the foramen of Bochdaleki. Again, more or less weak spots are left at the openings for the passage through the diaphragm of such structures as the œsophagus, splanchnic nerves and aorta. Hernias occurring through these apertures occur most commonly through the one for the œsophagus, next in frequency through that for the splanchnic nerves, and rarely occur through the aortic opening. Graser § in 1904 stated that no case had been reported as occurring through the opening for vena cava.

The traumatic variety of diaphragmatic hernia is caused by the following types of injuries: By a man being forcibly doubled up with his head between his feet, as in a land-slide; by severe concussion of the chest, as by a fall from a height; by stab wounds of the lower thorax; and by gunshot wounds. The last-mentioned agency was the cause of a large number of reported cases during the late war. Stab wounds also account for a large number of the traumatic variety, while the other causes mentioned are decidedly in the minority.

The following case is considered worth while reporting as having presented certain diagnostic difficulties:

J. D., white, male, aged sixty, janitor at the Hebrew Hospital, fell backwards out of a window at that institution on October 19, 1920 and landed on a pile of coal twelve to fourteen feet below. Several people immediately went to his aid, and when reached he

‡ Since this article was written an interesting paper by Cutler and Cooper on "Congenital Deficiency of the Diaphragm" has appeared. The embryology of the diaphragm is gone into in considerable detail.—See Cutler, E. C. and Cooper, H. S. F., Archives of Surg., Mar., 1924, vol. viii, pp. 506–523.

§ Von Bergmann's "System of Practical Surgery," vol. iv, p. 626.

was found sitting with his back against the wall of the building, pressing his epigastrium with his hands and groaning. He was at once admitted to the hospital. Physical examination on admission—2:15 P.M.—was as follows: Moderate surgical shock. Pulse 96, of good volume, irregular with occasional extra systoles. Temperature (rectal) 98.4° Respirations 28. Blood-pressure: Systolic 98; diastolic 70. He was conscious, but extremely pale, and complained of pains in the left arm and over the left lower chest. He was covered with beads of cold perspiration. There was a minor scalp wound in the fronto-parietal region, but no depression of the skull. The left humerus was fractured at its middle third. The chief interest centred in the chest. There was marked crepitation of the soft parts in the left axilla extending to the base of the chest and posteriorly to the interscapular region. Marked tenderness along all the ribs of the lower two-thirds of the left chest. The percussion note over the entire left chest was tympanitic. Breath sounds were audible but masked by the crepitation of the soft parts. No fluid was made out, but owing to the patient's serious condition a thorough examination was impossible. Examination of the right side of the chest was essentially negative. The heart could not be outlined by percussion and the heart sounds were barely audible, in fact it was difficult to ascertain whether they were actually being heard at all or not. The upper abdomen was held moderately tense, but there was no marked rigidity and no muscle spasm. There were no signs of fluid in the abdominal cavity. No abnormal masses.

A diagnosis of fractured ribs, punctured lung, and pneumo-hæmothorax was made. On account of the negative signs in the abdomen a ruptured diaphragm was not considered.

The patient was given stimulants and treated for shock. He had to be given morphia on account of the intense pain in his chest. At 7 P.M. the respirations were more labored and rapid, pulse of poor quality, and the patient seemed to be in a stupor. At 1:30 A.M. patient became restless, pulse 70, weak, irregular, intermittent, and he was again given morphia. Pulse became progressively weaker and respirations more labored and he died at 4:22 A.M., about fourteen hours after injury.

Autopsy Findings.—These were negative except for the local conditions encountered. The dome of the diaphragm on the left side was ruptured and the entire stomach, transverse colon and a portion of the small intestine had herniated into the left pleural cavity. The left lung was collapsed. All the ribs on the left side from the fourth to the twelfth inclusive were fractured, the point of fracture in the fourth being about two inches from the spine, and that in the others at increasing distances therefrom, proceeding downward. The sharp perforating ends of these ribs projected into the pleural cavity and perforated both the lung and the stomach. The left pleural cavity contained blood and stomach contents. The right pleural cavity was normal. The heart was displaced to the right. The peritoneal cavity contained neither fluid nor blood, due to the fact that the rupture in the diaphragm was tightly constricted around the neck of the herniated mass of organs. This explains the almost complete absence of abdominal signs after the injury.

The following cases gathered from the literature illustrate the types of cases that are successfully diagnosed and operated upon during life:

GIFFEN (1912), reports a case of a man twenty years old who was caught in a sand-slide and forcibly doubled up with his head between his feet. He suffered intense pain in the abdomen and chest and was confined to his bed for five weeks but no diagnosis was made. During the following year he had attacks of severe epigastric pain at intervals. He then came into Giffen's hands and a diagnosis of diaphragmatic hernia was made from the history of the injury, and the physical signs in the chest, *viz.*: tympany, heart displaced to the right, and distant heart sounds. Operation by the abdominal route showed an opening in the left half of the diaphragm with the stomach, transverse colon, spleen, twelve inches of jejunum and the tail of the pancreas in the left pleural cavity. Lung completely collapsed. The patient recovered and six week after operation the lung was almost completely expanded.

It was noted that during the operation tremendous traction was exerted by the chest cavity on the herniated organs, making it extremely difficult to replace them in their normal habitat. This difficulty has been encountered by other surgeons and is one of the principal objections raised to operation for diaphragmatic hernia by the abdominal route.

In 1914, STUART MCGUIRE reported two cases upon which he had successfully operated. The first case was a male, aged nineteen, operated upon four months after a stab wound of the left chest. The stomach was found in the left pleural cavity. The second case was that of a male, aged thirty-four, who fell a distance of 34 feet from a roof. Following the fall he was in bed for six weeks and when he got up noticed a gurgling sound in his left chest similar to what he had frequently felt in the abdomen before the accident. A year later he went to Doctor McGuire on account of a persistent and severe grade of indigestion and shortness of breath. X-ray after a bismuth meal showed practically the entire stomach in the left pleural cavity. Both these patients were operated upon by the thoracic route, using the Cranwell trap door of the full thickness of the thoracic wall.

In 1915, DAVIS of Birmingham reported five cases, upon four of which he had operated. The first case was seen in 1902, and was that of a stoutly built fireman, who while holding a nozzle on a ladder was suddenly wrenched to one side and severely strained. In Davis' absence he was treated by an assistant for four days without operation, and died. The diagnosis was not made until autopsy in spite of the fact that the abdomen had been rigid from the time of the accident. Autopsy revealed a rent in the diaphragm with the entire stomach and part of the transverse colon in the pleural cavity.

Davis' other four cases followed stab wounds of the thorax and were all correctly diagnosed and successfully operated.

GALE in 1920 reported a case of a man twenty years old, who was struck in the lumbar region by a travelling crane. Although the abdomen was rigid, the heart was displaced to the right, there was tympany over the left chest and distant breath sounds, the diagnosis was not made until the patient was X-rayed. He was operated upon by the thoracic route. A rent was found in the diaphragm, and the stomach, transverse colon and spleen were in the left pleural cavity. These organs were replaced in the abdomen and the rent in the diaphragm repaired. Patient was alive and doing well six weeks after operation, but he also had a comminuted fracture of the 4th lumbar vertebra and the final outcome of the case is not stated in the report.

RANKINE in 1920 reported the case of a boy, eight years of age, who was run over by the hind wheel of a motor bread van. The patient was in great pain and the abdomen was rigid. Immediate abdominal exploration was performed and revealed the presence of a small amount of blood in the peritoneal cavity but no injury to the liver, intestines, bladder or kidneys. However, when the left upper quadrant was explored it was found that the spleen and stomach had herniated into the pleural cavity through a rent in the diaphragm. The abdominal wound was closed and an osteoplastic flap turned back in the axillary portion of the left thoracic wall. The stomach and spleen were replaced and the tear in the diaphragm sutured. Recovery was uneventful and a week later it was noted that there was "evidence of the lung expanding." Examination six years after the accident showed no deformity of the chest wall, expansion good on the left side, and a radiogram showed the dome of the diaphragm to be in normal position.

An example of a diaphragmatic hernia following a perforating gunshot wound of the chest is shown by the following case reported by UNGER and WESKI: The patient was a twenty-nine-year-old German officer, who had a perforating wound of the chest in May, 1915, the bullet entering in the 7th intercostal space. There was immediate healing of the wound without operation and the patient had no symptoms after healing until June, 1916 (thirteen months later) when he began to have pain in the left thorax. These symptoms increased until September when the patient underwent operation. The stomach, pancreas

and a large part of the large intestine were found protruding into the thoracic cavity through a large hole in the diaphragm. These were replaced and the diaphragm sutured. The patient did well for three weeks when he had to undergo a second laparotomy for intestinal obstruction due to adhesions, and four days following this he died. Autopsy showed the diaphragm to be perfectly healed.

The authors explained the course of this man's symptoms by saying that the original hole in the diaphragm was a small one which gradually enlarged and gradually permitted the entrance of more and more of the abdominal organs into the thoracic cavity.

The non-traumatic cases which come to operation are generally operated upon for intestinal obstruction, and, as stated above, the cause of the obstruction in very few of these cases has been diagnosed before operation. However, Stone has furnished an example of the exception to this rule in a case which he recently reported. Diagnosis was made by the physical signs in the chest and the X-ray. Operation was done by combined thoracic and abdominal approach. A loop of bowel was found caught in a small diaphragmatic hernia, and this could not be reduced until the hernia opening was enlarged. The patient made an uneventful recovery.

These cases are illustrative of the types of cases encountered clinically. However, the discrepancy between the number of cases diagnosed clinically and the number of cases encountered at autopsy would lead one to believe that a great many symptoms in chronic patients which are unexplained by the usual diagnostic procedures may be due in certain instances to undiscovered diaphragmatic hernias. The diagnosis of the type of case that we have dealt with here depends upon three things: First, careful inquiry as to previous history of injury; second, the physical examination of the chest; and third, radiographic and fluoroscopic findings.

Conditions which might be confounded with this condition are hydropneumothorax or pyopneumothorax, subphrenic gas abscess, large cavity in the lower lobe of the lung, and eventration of the diaphragm. It is not always possible to differentiate diaphragmatic hernia from these conditions by physical signs alone. The symptoms and physical signs vary with the complications present. There is no typical picture which characterizes the condition, as is indicated by the comparatively few times the correct diagnosis is made before operation or autopsy; but with the aid of a careful history, the X-ray, and the exploratory puncture it is possible to rule out the conditions mentioned above. In hydropneumothorax and pyopneumothorax the coin sign and the exploratory puncture are valuable aids to diagnosis. The X-ray should effectually rule out a large cavity in the lower lobe of the lung, or subphrenic gas abscess. Likewise is the X-ray of great value in differentiating between eventration of the diaphragm and diaphragmatic hernia, the contour of the diaphragm being smooth in the case of eventration and having an irregular protrusion in the case of hernia. Schlippe has given us another differential point between these two conditions, namely, that of noting the fluctuation of intragastric pressure with expiration and inspiration. This

pressure can be determined by suitable apparatus introduced into the stomach. Normally the intragastric pressure rises with inspiration and falls with expiration, but when the stomach lies in the pleural cavity the reverse is true.

As to the treatment of rupture of the diaphragm, operation should be performed as soon as the condition of the patient will permit—at once if there is evidence of strangulation or a ruptured viscus. Some cases are so badly shocked that it is necessary to institute anti-shock measures before any operative procedure can be attempted. Graser || emphasizes the importance of closing the opening immediately and states that experience shows that most injuries of the diaphragm are followed sooner or later by fatal strangulated hernia. He further states that "according to Lacher, of 36 cases of injury to the diaphragm that were not operated upon immediately, 5 died within one day, 10 within a month, 5 within five years, and 5 in twenty years, all of the effects of diaphragmatic hernia."

Of the two operative routes, namely, the abdominal and the thoracic, the thoracic has two very great advantages. In the first place opening the thorax does away with the intra-thoracic negative pressure and makes it a simple matter to reduce the herniated organs. In the second place, suture of the diaphragm is an easy matter from this approach and may be very difficult, if not well nigh impossible, through the abdomen.

The great advantage of the abdominal route is that of being able to repair any damage to abdominal viscera without making a second incision. It is often necessary, especially in the case of stab wounds, to open the abdomen in order to repair a hole in the stomach or a cut in the spleen, even in cases where the thoracic route has been used for the repair of the injured diaphragm.

An objection often raised to the thoracic route, and a point urged in favor of the abdominal route, is the danger of pneumothorax from the thoracic opening. This argument, however, has little to support it, as the air has equally as good an opportunity to enter the thorax from the abdomen through the hole in the diaphragm as from the opening in the thoracic wall. War experiences in thoracic surgery have largely tended to remove the fear of pneumothorax.

The majority of surgeons who have operated on these cases now seem to consider the thoracic route preferable, even in cases where it is necessary to open the abdomen also to repair abdominal viscera. Stone advocates the combined thoracic and abdominal approach. This method seems ideal, as one has the combined advantages of being able to explore the abdomen, which is nearly always advisable in these cases, and also the technical advantages offered by a thoracic incision. The necessity of making two incisions adds little, if any, to the length of the operation, as this slight increase in the time required is readily offset by the additional ease with which the operation is performed. The advantage of being able to get a hand on each side of the

|| Von Bergmann's "System of Surgery," vol. iv, p. 626.

diaphragm is a considerable time-saving factor. The French have even gone a step further and we find Auvray advocating an incision starting in the thorax and extending down through the abdominal wall, dividing the costal cartilages and splitting the diaphragm down to the hernia opening. Such a radical procedure, however, seems to be unnecessary.

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AN EXTRAPERITONEAL INTRAPLEURAL ROUTE OF APPROACH FOR INTRATHORACIC SURGERY

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The rigidity of the chest wall is a very essential factor in the physiology of the intrathoracic organs. It is instrumental in keeping up with the negative intrapleural pressure so that intrathoracic organs function properly. In operations involving the thoracic viscera where the ribs have to be resected, a permanent deformity of the chest wall is produced with subsequent permanent loss of the rigidity of the chest wall. Such a defect impairs normal respiration by mechanically diminishing the vital capacity of the lungs and thus exposing the patients to an added respiratory and circulatory strain. In a previous paper (M. Joannides, Arch. Int. Med., Jan., 1924, vol. xxxiii, pp. 145–154) it was shown that in dyspnœic conditions the ultimate voluntary reserve of increase in the amplitude of respiration becomes diminished in direct proportion to the degree of dyspnœa. The term "ultimate voluntary reserve" is used to signify the difference in volume of air between the vital capacity and tidal air in conditions of dyspnœa. If, then, the patient develops heart disease or pneumonia and thus his respiratory reserve is diminished, he will, undoubtedly, either die or else find himself in extreme difficulties when he has a flabby non-rigid chest wall in addition to his heart and lung disturbance. A number of intrathoracic operations such as those performed on the œsophagus, the lungs, the heart, and the mediastinum are frequently life-

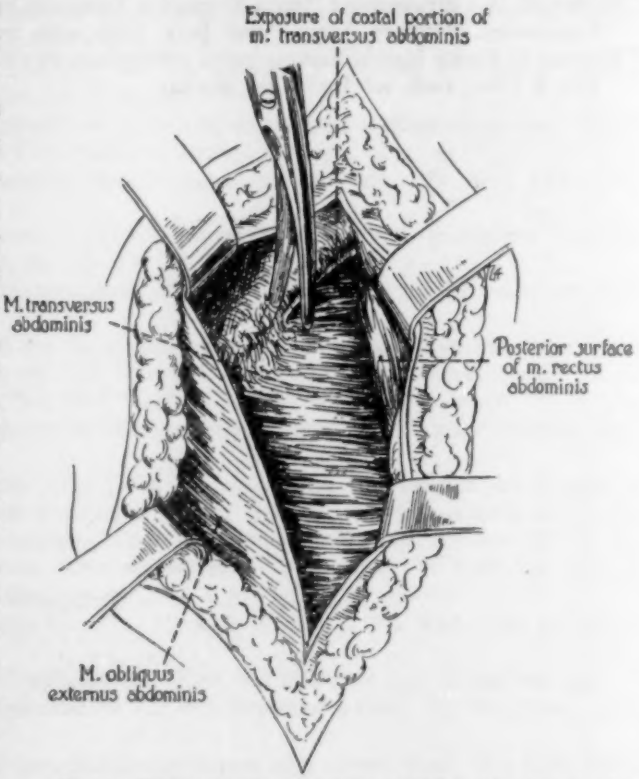
Exposure of costal portion of m. transversus abdominis
M. transversus abdominis
Posterior surface of m. rectus abdominis
M. obliquus externus abdominis

Fig. 1.—Shows retraction of rectus and oblique abdominal muscles. Dissection of costal portion of transversus abdominis muscle before it is incised at its attachment.

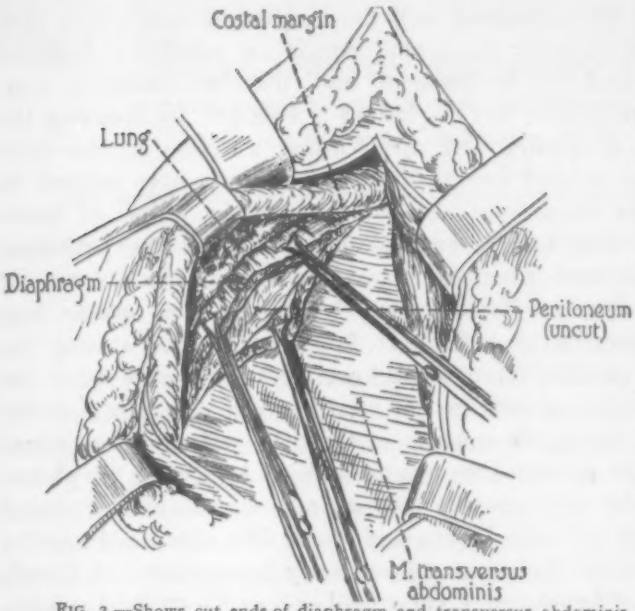

FIG. 2.—Shows cut ends of diaphragm and transversus abdominis muscles with uncut peritoneum coming into view. By lifting on the costal margin, tip of lower lobe of lung comes into view.

saving measures. Most procedures, however, require resection of one or more ribs in order to get a satisfactory exposure. The route which is described here preserves the rigidity of the chest wall and at the same time makes the various intrathoracic organs quite accessible, particularly those in the lower thorax. With the aid of artificial respiration the pleural cavity may be left open over prolonged periods, and thus various types of operations may be performed without the necessity of unnecessary haste which very frequently proves detrimental to the patient.

The Operation.—A high rectus incision is made and the fascia of the external and internal oblique muscles is incised at the point of the junction to the fascia of the rectus muscle. The muscles are then retracted and the costal attachments of the transversus abdominis are exposed by means of blunt dissection. The transversus abdominis muscle is then incised as close to its costal attachment as possible. At this point the peritoneum may become exposed and care must be taken not to incise

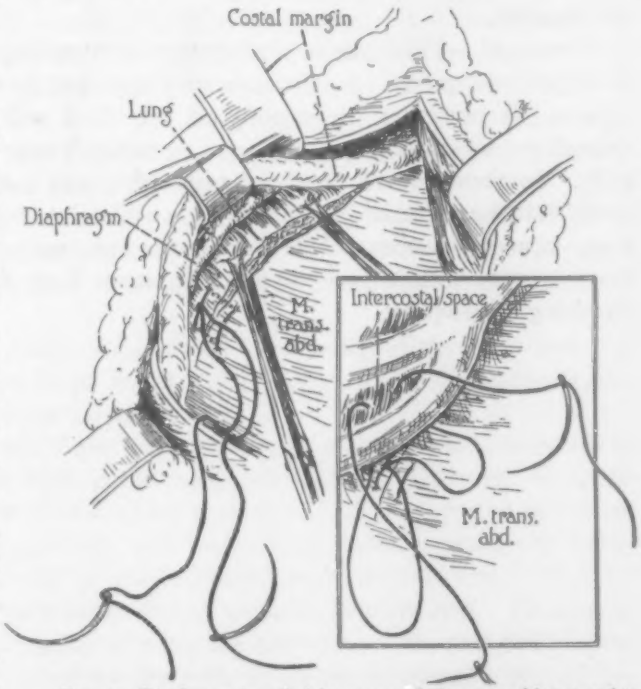

FIG. 3.—Diaphragm is pulled by means of clamps and is sutured to transversus abdominis muscle. Pleural cavity open with tip of lung showing. Insert shows suturing of abdominal muscles to chest wall.

it. By pulling gently the abdominal wall the diaphragm comes into view and this is incised as close to the costal margin as possible. Artificial respiration is now started and is continued until the chest cavity is completely closed. The incision of the diaphragm is enlarged by inserting the finger through the first opening and then cutting as close to the chest wall as possible. The severed end of the diaphragm is now sutured to the cut portions of the transversus abdominis muscle by means of interrupted sutures. This step assures an absolute closure of the peritoneal cavity and at the same time prepares the muscles for hurried closure if that ever becomes necessary. This is done by leaving the sutures long and having needles inserted to each end of the suture and closing the wound by passing the needles through the lowermost intercostal space and tying the sutures. Additional sutures are used to make the pleural cavity absolutely air tight by sewing the muscles to the chest wall at points where air is noticed to enter and go out of the pleural cavity. As soon as the pleural cavity is closed artificial respiration is stopped and the air in the pleural cavity is removed by the use of a Potain aspirator. The abdominal muscles may be sutured in layers in the same manner as any laparotomy. A Gesell-Erlanger (Amer. Jour. Physiol., 1914, vol. xxxiii, p. xxxiii) artificial respiration tank is used to produce positive pressure respiration. This chamber is preferable because it conforms to physiologic conditions of respiration more closely than any other instrument. It is intermittent and the rate of respiration can be regulated by increasing or decreasing the amount of air intake in the chamber.

Comment.—This route is of advantage in intrathoracic surgery particularly in aseptic operations. It offers an easy approach to the lower intrathoracic organs. It preserves the rigidity of the chest wall. Out of twenty-two animals on whom the operation was performed, only two dogs died on the table. In these animals artificial respiration was not satisfactory, with the result that the animals died of asphyxia. Details of the experiments will be given in another paper. The operation is apparently quite harmless because there is very little injury to the diaphragm both from an anatomic and physiologic viewpoint.

ACUTE APPENDICITIS IN THE INFANT

FACTORS ACCOUNTABLE FOR ITS HIGH MORTALITY

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In a recent study (Annals of Surgery, vol. lxxix, 1924, p. 538) of 145 cases of acute appendicitis in children (up to and including the twelfth year), it was found that the disease occurred in the first five years of life in 11.7 per cent. of the cases (17 patients) and that the mortality was 35 per cent. Comparing this with the mortality of the entire series, 7.58 per cent., it is seen to be surprisingly high as six of the eleven deaths of the series were during this half decade. An additional fact brought out by the study was that all the appendices of the children under five years of age had perforated before they were operated upon.

Because of these outstanding facts, it was decided to make a further study of acute appendicitis occurring in the first half decade of life. In a review of all the case histories since the establishment of the Children's Surgical Service at Bellevue Hospital in the autumn of 1916 up to the present (June, 1924), there were found forty-three cases of acute appendicitis in children under five years of age (these include the seventeen cases reported in the previous series).

Acute appendicitis is a comparatively infrequent condition during the first five years of life, seldom occurring before the third year. In our previous series in children it appeared in 11.7 per cent. at this age. Gatch and Durman (Annals of Surgery, vol. lxxix, 1924, p. 862) had three cases under five years in a series of 262 of all ages, being a percentage of 1.14 and 10 per cent. of their cases in the first decade.

Our youngest patient was twenty months old and we had ten in the third year, nine in the fourth year and twenty-three in the fifth year. One case as early as the first month of life and several in the first year have been reported in literature.

The preponderance of the incidence of the disease in the male over the female is similar to that found in later life; there were twenty-seven cases in the former and sixteen in the latter.

The mortality of these forty-three cases was 25.6 per cent., there being eleven deaths. This is high when compared with the mortality of acute appendicitis of childhood or of a series of all ages. In our series of childhood the mortality was 7.58 per cent. and Bancroft (J.A.M.A., 1920, vol. lxxv, p. 1635) reported a mortality of 10.9 per cent. for the first decade. The mortality for a series of all ages varies from 6 per cent. to 9 per cent. (It may be noted that in this larger number of cases the mortality of the first half decade was 25.6 per cent. instead of 35 per cent. as in the seventeen cases of the former series.)

The mortality rate was about the same in the two sexes, though in later life it is relatively higher in the female than in the male. The mortality rate was higher the younger the individual, in the second year 100 per cent., in the third year 60 per cent., in the fourth year 22.2 per cent., and in the fifth year 8.6 per cent.

At operation it was found that in three of the patients the appendix had not perforated. These were all operated upon within twenty-four hours of the onset of the disease and there were no deaths among them. There were seventeen which had localized abscess and were operated upon on an average of four days after the appearance of the first symptoms. In this group there was one death from a status lymphaticus which was confirmed by autopsy. Of the twenty-three remaining cases with diffuse peritonitis, the time lapsing before operation was three days and there were ten deaths (43.5 per cent.). The facts to be brought out are that perforation of the appendix takes place relatively earlier in infants than in older patients, that a spreading peritonitis is the most frequent result of the perforation and that the high mortality of acute appendicitis in infancy is due to the complication of a spreading peritonitis, to which the resistance of the infant is less than the older child, the mortality of the former being 43.5 per cent. and of the latter 18.2 per cent. Spreading peritonitis was accountable for ten of the eleven deaths.

TABLE I

Showing the Greater Frequency of Perforation with Spreading Peritonitis in Infancy Producing the Higher Mortality

	Unperforated		Abscess		Spreading Peritonitis	
	Per cent. of cases	Deaths	Per cent. of cases	Deaths	Per cent. of cases	Deaths
Series of children up to 13 years	33.1	0	36.4	5.7%	30.4	18.2%
Series of children in first half decade	6.9	0	39.5	5.9%	53.5	43.5%

Another fact brought out from a study of the cases is that the younger the individual, the more apt is he or she to develop spreading peritonitis, while as age advances the peritoneum appears to develop the power of walling off infection. This is apparent in the following table, where it is seen that the percentage of cases with abscess, for a given age, is highest in the fifth year, while the percentage of those with spreading peritonitis is lowest. (Table II.)

In twenty-three records the fact was mentioned that a cathartic had been given the child previous to admission. At times the dose, which was usually castor oil, was repeated. None of the unperforated cases received the purge; nine of those with abscess and fourteen of those with spreading peritonitis were purged. At times the child relieved itself of the medicine by immediately vomiting. Of the ten patients with spreading peritonitis who died, it is stated that six received castor oil and two of the remaining had frequent enemas.

In only a few instances did the records mention the fact that a physician had been called in before the patient was admitted. Usually when one had

been consulted the child was sent to the hospital, but in four records it was mentioned that the patient had seen a doctor at least twenty-four hours before admission and he had prescribed a cathartic.

TABLE II

Age	No. of cases in series	Spreading peritonitis				Abscess				Unperforated		
		No. of cases	Per cent.	Deaths		No. of cases	Per cent.	Deaths		No. of cases	Per cent.	Death
				No. of cases	Per cent.			No. of cases	Per cent.			
Second year ...	1	1	100	1	100	0	0	0	0	0	0	No deaths
Third year	10	6	60	6	100	3	30	0	0	1	10	
Fourth year...	9	6	66	1	16.6	3	33.33	1	33.33	0	0	
Fifth year.....	23	10	43	2	20	11	47.8	0	0	2	8.7	

To reduce the death rate it is necessary to make an early diagnosis, to prevent perforation if possible, and if perforation takes place, to help the peritoneum localize the infection.

Diagnosis of acute abdominal conditions during early childhood is difficult as we have not the coöperation of the patient, and the early symptoms are so similar to those of the more common gastro-intestinal and respiratory diseases and pyelitis. Acute appendicitis is usually ushered in with vomiting. This occurred in thirty-six of our forty-three cases. In four histories it was stated that the patient had not vomited and in the three remaining no mention of vomiting was made. The child becomes prostrated and apathetic, lies quietly on its back in bed with its legs slightly drawn up. A child with peritoneal inflammation will not sit up. The appearances are that the child is suffering severe pain, but it is usually impossible to obtain definite knowledge of its character and location. The bowels are commonly constipated but occasionally there may be diarrhœa. In the examination a careful inspection is of the greatest importance; the position of the child in bed should be observed and it should be particularly noted whether the respiration is of the abdominal or thoracic type. Abdominal respiration is almost always absent when there is peritoneal inflammation. The symptoms of rigidity and tenderness are difficult to interpret. The abdomen is usually distended and attempts at examination cause the child to resist. It is well to make the examination before the patient is upset. The hand should be gently placed upon the abdomen and in a few moments, when the child has become accustomed to its presence, gentle, firm pressure can be made to elicit muscle spasm. If the child cries and cannot be quieted, the amount of spasm present can be observed during the act of inspiration. At times rigidity of the abdominal muscles is entirely absent, although a spreading peritonitis is present.

The presence of, locality and amount of tenderness is very difficult to determine. In the rectal examination, however, which should never be omitted, the location of the tenderness can frequently be demonstrated.

Intra-abdominal masses can at times be found, though often the mass may prove to be impacted fæces. Here again the rectal examination is of the greatest help.

A rise in body temperature is usually present, though at times the temperature registers normal. A temperature over 102.5 is seldom found. The pulse as well as the respiratory rate is usually up.

The white blood and differential counts are of importance to help confirm the diagnosis, but from a prognostic point of view are of little use. It is needless to state that operation should be performed as soon as a diagnosis is made.

To Summarize.—Acute appendicitis in infancy is a comparatively rare condition and seldom seen before the second year of life. But the mortality is relatively much higher than in later life. The relatively high death rate is due to the higher percentage of rapid perforations followed by spreading peritonitis. The younger the infant the greater is the chance of its developing spreading peritonitis and the less chance has its peritoneum of localizing infection. Cathartics undoubtedly precipitate perforation in many cases. Delay in operative interference is due to tardiness of the parents in consulting medical aid and the difficulty of making a diagnosis when a physician sees the patient at the onset.

THE CLINICAL SIGNIFICANCE OF THE RELATION OF TOTAL AND DIFFERENTIAL LEUCOCYTE COUNTS IN ACUTE APPENDICITIS

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and

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I. Introduction.—We wish to present in some detail the relationship between the total leucocyte count and the percentage of polymorphonuclear leucocytes in 309 cases of acute appendicitis, with special reference to the effect upon this relationship of sex, age, temperature, pathological process, and infecting organism.

The cases of appendicitis summarized and analyzed in this paper are from the First (Cornell) Surgical Division of New York Hospital, during the last three years. The operations were performed by Dr. Charles L. Gibson, Chief, Dr. Burton J. Lee, Dr. James M. Hitzrot, and Dr. Charles E. Farr. We wish to express our indebtedness to Doctor Gibson for his kindly criticisms and suggestions throughout this work, as well as his permission to use these cases from his service.

II. Previous Work.—1. *Leucocytosis.* The blood picture has been used clinically in surgical conditions as a very important point in the diagnosis, as an indication for operation, and in prognosis, for many years. Cabot,[1] in 1894, in a series of cases, noted leucocytosis in every case in which pus was present except two. Sadler,[2] two years previously, claimed that leucocytosis was generally, though not invariably, present in conditions attended with an exudate of any kind, except tuberculosis. Greenough[3] believed a count of 20,000 or more on the first or second day suggested general peritonitis. Coste[4] held that a count of over 22,000 was indicative of an abscess; Curshmann[5] believed a count of 25,000 or more suspicious of pus, while Stadler[6] also believed this figure indicative of pus. French[7] placed the low figure at 35,000. There is a noticeable scarcity of mention of the differential count among workers before 1905.

The use of the total leucocyte count as an indication for operation was widely used, with little reference to the differential count. Bloodgood[8] believed a leucocytosis of 18,000 or more within the first forty-eight hours should be considered an indication for operation, specially with an increasing count. Joy and Wright[9] believed a high stationary or an increasing count indicates a morbid condition of increasing severity which demands operation no matter what the clinical symptoms may be. Aldous[10] believes a count of from 15–30,000 demands immediate operative attention in doubtful cases. And on the other hand, these writers interpret the falling count as an abating

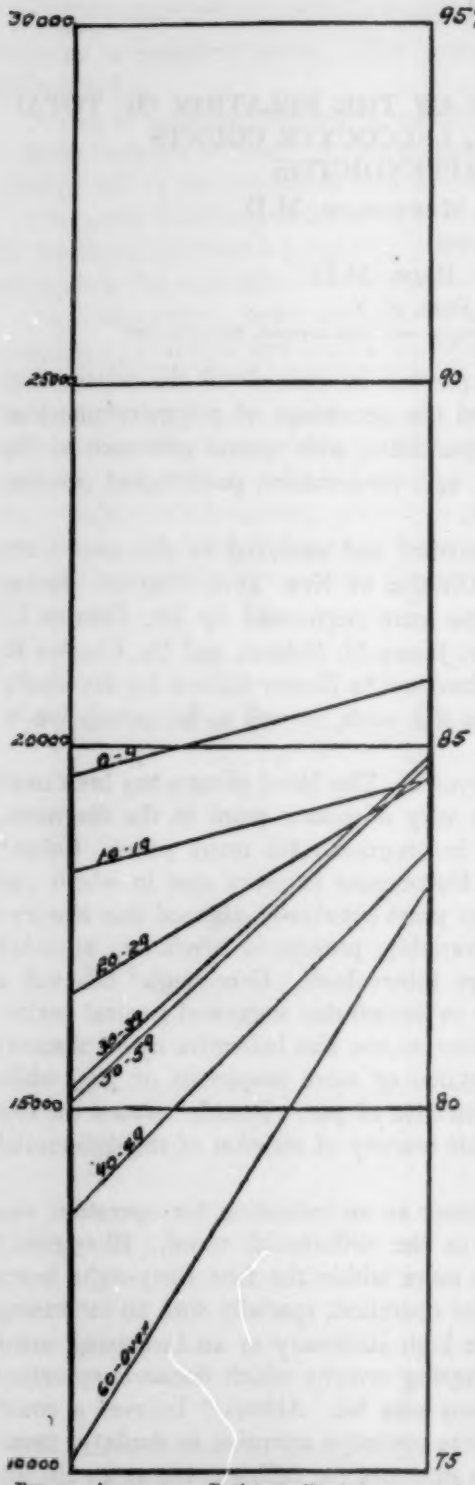

FIG. 1.—Age groups. Resistance line in 309 cases of acute appendicitis.

sign. Somewhat similar views were held by Kühn,[11] Locke and Cabot,[12] and Curshmann.[5] DaCosta,[13] in 1905, summed up the more conservative opinion in a rather widely quoted statement: "The surgeon who attempts to use the blood count in appendicitis as a definite pathognomonic sign will soon run afoul of diagnostic disasters, but he who regards it only as a symptom invariably to be correlated with equally if not more important clinical manifestations, cannot fail to find this method of inquiry of signal value in routine clinical surgery." And a similar view is expressed by Longridge,[14] Cabot,[15] Richardson,[16] French,[7] Gerngoss,[17] Federmann,[18] and Stadler.[6] The fallacy of deciding on an operation from the blood count alone was early pointed out. Ewing[19] quotes one of Cabot's cases with 33,000 leucocytes which recovered without interference.

2. *Polymorphonuclear Percentage.*—In 1901, Wilson[20] noted the importance of the differential count, stating that 80–85 per cent. polymorphonuclear cells without an increase in total white blood cells was suspiciously high, and over 90 per cent. was still more indicative of a process, usually suggestive of pus. However it was Sondern[21] who first put forth the rather revolutionary idea that the degree of leucocytosis indicates the amount of body resistance and the degree of polynucleosis indicates the severity of the inflammatory process, while the most important point both in the diagnosis and prognosis is

the relationship between these two. Sondern's ideas were applied clinically by Gibson [22] on a series of cases, with the conclusion that "the differential blood count and its relation to the total leucocytosis is to-day the most valuable diagnostic and prognostic aid in acute surgical diseases that is furnished by any method of blood examination."

3. *Leucocyte Charts.*—In his application of Sondern's principles Gibson [22] devised a "standard chart," on which he could portray the relationship of leucocytosis and polynucleosis. He takes as the normal extreme white count 10,000 and the normal extreme polymorphonuclear percentage as 75. The total white count is charted on the left side of the chart and the percentage of polymorphonuclears on the right side, with a rise of one per cent. in polymorphonuclears with each increase in the total white count of 1000 cells. Hence 10,000 is connected with 75 per cent. by a horizontal line, 15,000 with 80 per cent., 20,000 with 85 per cent., etc. With a proportional increase in these two factors, a horizontal line results; with a low total white count and a high percentage of polymorphonuclears, a rising line; and with a high total count and low percentage of polymorphonuclears, a falling line. Hence applying Sondern's principle, a rising line means a relatively poorer body resistance with a more severe inflammatory condition, and hence a more guarded prognosis. And conversely a falling line portrays a proportional good resistance with a less severe infection, and so a better prognosis.

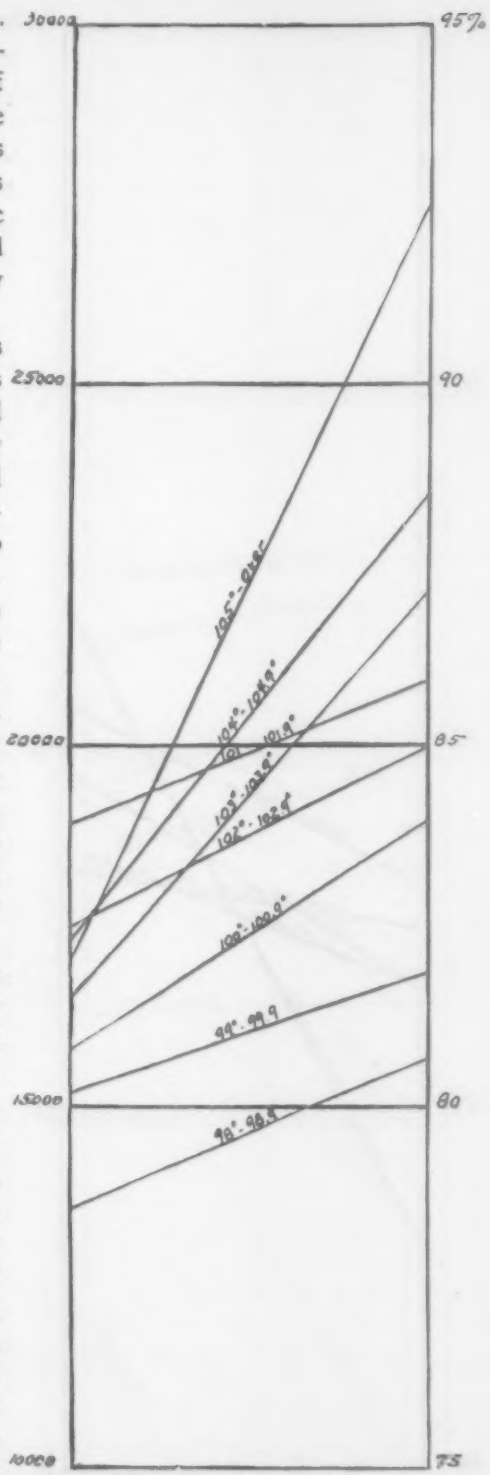

FIG. 2.—Temperature group. Resistance line in 309 cases of acute appendicitis.

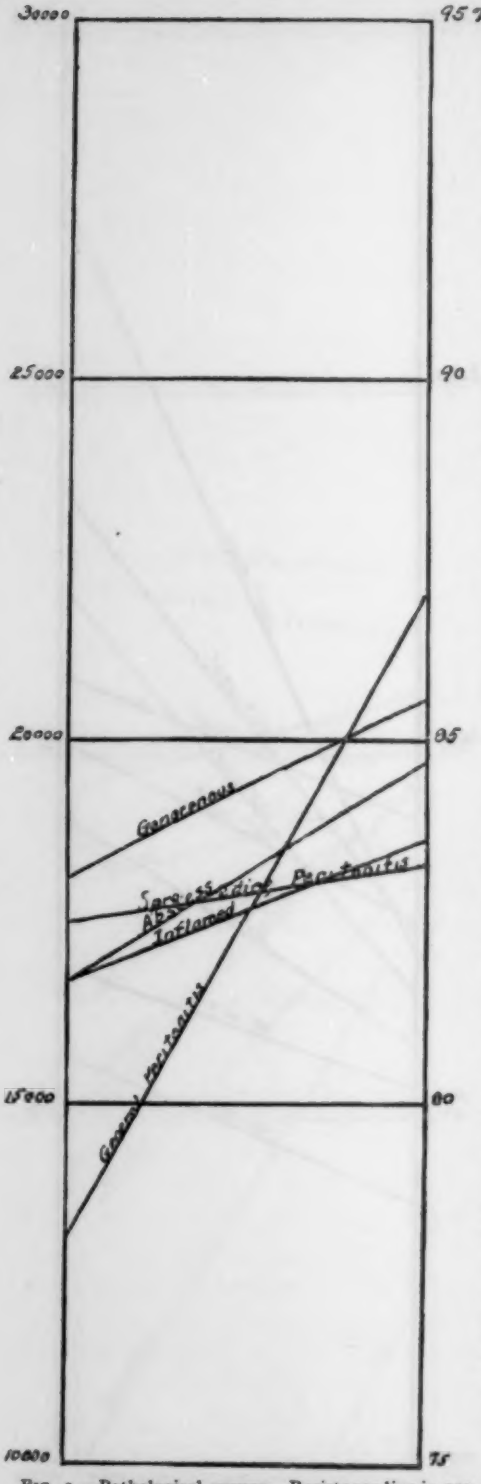

FIG. 3.—Pathological groups. Resistance line in 309 cases of acute appendicitis.

Following Gibson, several writers have proposed methods of graphically expressing this relationship. Wilson,[23] in 1908, and Lampe,[24] in 1911, used a modified chart on which they could chart the daily total leucocyte count and the percentage of polymorphonuclears separately, using the same standards of normal as Gibson, and on a given day the two lines to be connected by a third line—the "resistance line." Coons and Bratton [25] suggested a chart on Gibson's plan, beginning with the same normals of 10,000 and 75 per cent., but mathematically figured out on the principle that the polymorphonuclears are affected in acute septic processes and that other cells remain approximately normal throughout if resistance is good. Hence, if with a total white count of 10,000, 75 per cent. are polymorphonuclears, then with 20,000 leucocytes, 87.5 per cent. would be polymorphonuclears; with 30,000, 91.6 per cent. would be polymorphonuclears, etc. Watters [26] has suggested a modified Wilson chart which charts separately the neutrophile percentage and the total leucocyte count in the same vertical plane, and the patient's condition is judged by the relation of these lines to each other. The most recent attempt to picture this relationship graphically has been made by Walker,[27] who by a simple formula figures out the disproportion as it would be shown on Gibson's chart, and then charts this disproportion figure from day to day.

The present writers have used in the analysis of this series the original Gibson chart, realizing that

while it has faults, they are perhaps less than any of the others. We believe Walker's index to be very valuable, but in a large active service where often only one preoperative and perhaps one or two or even no post-operative blood counts are made, it is not as useful as that suggested by Gibson.

4. *Leucocyte-polymorphonuclear Relationship.*—Sondern's ideas and Gibson's first clinical results have been verified by many workers and especially as applied to appendicitis. Wilson [20] and Fowler,[28] in 1908, were among the earliest to confirm the original findings. They agree that the degree of leucocytosis alone is too variable to rely upon; the p e r c e n t a g e of polymorphonuclears is a very important signal, but the most helpful diagnostic and prognostic point is the relationship of these two. This view is held also by Coons and Bratton,[25] Lampe,[24] Watters,[26] and m o r e r e c e n t l y by Hewitt,[29] Walker,[27] Greeley,[30] and Rice.[31] Gibson [32] again in 1919 verified his former findings; the results are given below. Contrasted to this view, Noehren [33] and Pease [34] and more recently, Jones and Brown,[35] believe the percentage of polymorphonuclears the most valuable sign. The former two workers hold that the number of exceptions to the relative disproportion is so great, that its practical value in determining immediate operation is very small. Jones and Brown hold it as reliable prognostic guide. Gibson's[32] summary for 705 cases of appendicitis appeared in Trans. Int. Surg. Cong., Paris, 1920. The data of this remarkably large series follow:

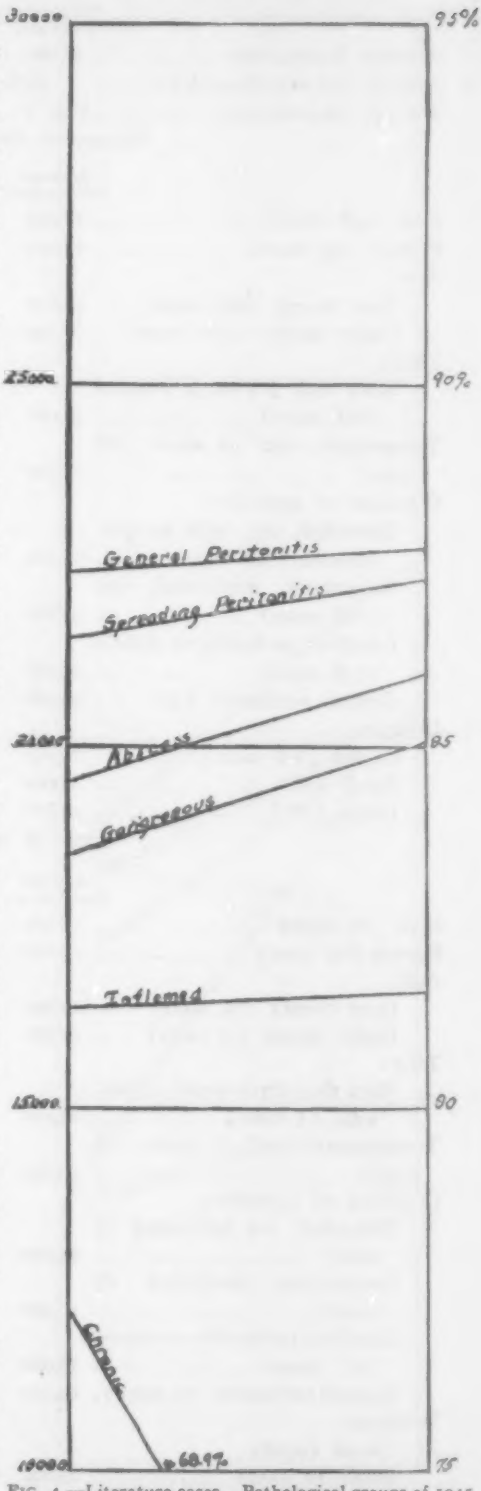

FIG. 4.—Literature cases. Pathological groups of 1945 cases of acute appendicitis.

	Total cases 705 cases	Recovered 675 cases	Died 30 cases
Average leucocytosis	18,000	18,000	18,000
Average polymorphonuclears	84%	84%	86%
Average disproportion	Plus 1	Plus 1	Plus 3

Recovered—675 cases

	Average leucocytosis	Average polymorphonuclears	Average disproportion
Male (438 cases)	18,000	84%	Plus 1
Female (237 cases)	18,000	83%	Horizontal
Age:			
Over twenty (384 cases)	17,000	83%	Plus 1
Under twenty (291 cases)	19,000	84%	Horizontal
Time:			
More than 3 wks. in hospital (158 cases)	20,000	84%	Minus 1
Temperature—102° or more (287 cases)	18,000	82%	Minus 1
Condition of appendix:			
Distended, etc., with no perforation (360 cases)	17,000	82%	Horizontal
Gangrenous, perforated, etc. (126 cases)	19,000	86%	Plus 2
Localized peritonitis or abscess (156 cases)	20,000	84%	Minus 1
General peritonitis (33)	19,000	85%	Plus 1
Drainage:			
Closed (288 cases)	16,000	82%	Plus 1
Small (98)	18,000	84%	Plus 1
Large (289)	20,000	85%	Horizontal

Died—30 cases

	Average leucocytosis	Average polymorphonuclears	Average disproportion
Male (16 cases)	18,000	87%	Plus 4
Female (14 cases)	18,000	85%	Plus 2
Age:			
Over twenty (19 cases)	19,000	89%	Plus 5
Under twenty (11 cases)	17,000	81%	Minus 1
Time:			
More than three weeks in hospital (3 cases)	23,000	86%	Minus 2
Temperature—102° or more (18 cases)	19,000	88%	Plus 4
Condition of appendix:			
Distended, not perforated (1 case)	23,000	93%	Plus 5
Gangrenous, perforated, (7 cases)	16,000	86%	Plus 5
Localized peritonitis or abscess (11 cases)	18,000	85%	Plus 2
General peritonitis (11 cases)	19,000	86%	Plus 2
Drainage:			
Closed (none)			
Small (1 case)	23,000	93%	Plus 5
Large (29 cases)	18,000	86%	Plus 3

III. The Present Work.—All data in this series was taken directly from the case histories. The blood counts were made, as a rule, by the junior interne on the service. Care was used to select only cases which had been in good health previous to the attack of appendicitis.

In the analysis of our series, as well as the literature, we constantly refer to the term disproportion, expressing it in a minus or plus figure. We refer to the disproportion between the leucocytosis and the polynucleosis. We have followed Gibson's example, using 1000 cells as a unit. When there are 10,000 leucocytes with 75 per cent. polymorphonuclears, there is a normal proportion or no disproportion, and these two figures are connected on the chart by a horizontal line. On the other hand, with 11,000 leucocytes and 75 per cent. polymorphonuclears, there is a disproportion of minus one, and a falling line connects the two figures. With 10,000 leucocytes, and 76 per cent. polymorphonuclears (the normal proportion for 11,000 white cells), there is a disproportion of a plus one, with a rising line. For the sake of accuracy in this work, we have analyzed our cases to 0.1 of a unit, although we realize this is probably not practical in routine work for individual cases, nor is it necessary.

1. *Sex and the Resistance Line.*—It is of interest to note in passing that 62 per cent. of our series of 209 acute cases were males. Maylord[36] found 51 per cent. males in 1000 cases; Deaver and Ravdin,[37] 52 per cent. in 500

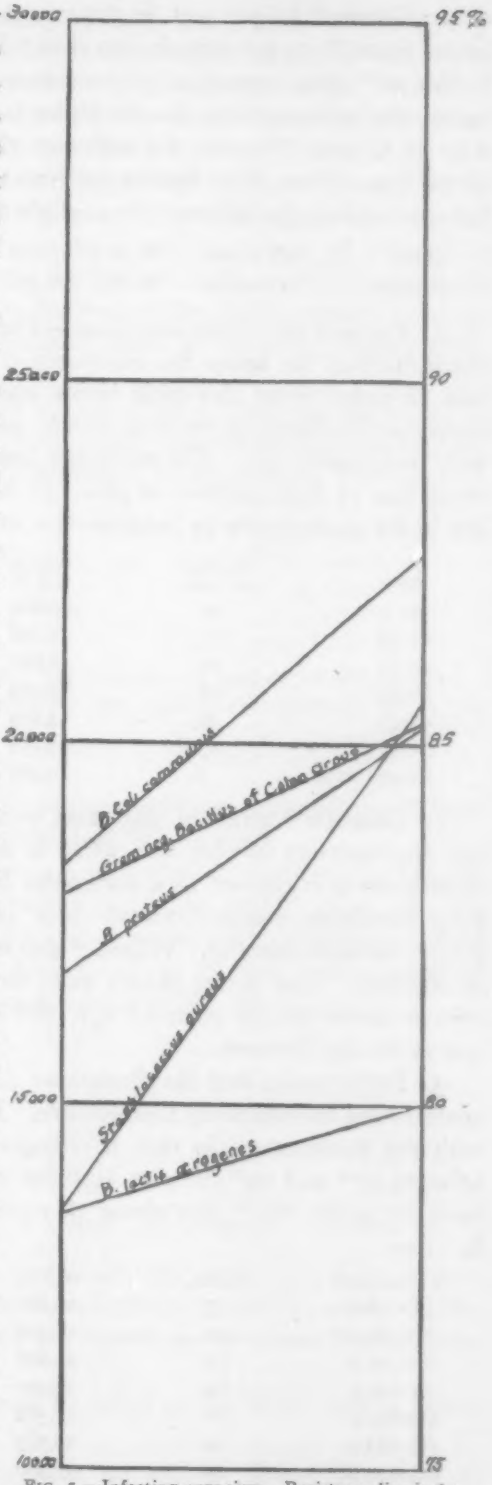

FIG. 5.—Infecting organism. Resistance line in 64 cases of acute appendicitis.

cases; Gibson,[32] 65 per cent. in 705 cases; Sonnenburg,[38] 67 per cent. in 1000 cases; Roux,[38] 53 per cent. in 670 cases; Barbier,[38] 76 per cent. in 616 cases; LaRoque[39] alone reports a predominance of females in 400 cases. In our series, the resistance line for the males is plus 2.5, and for the females plus 2.4. In Gibson's[32] series, the males are plus 1, and the females chart a horizontal line. From these figures the females show a slightly better resistance, but we feel that the difference is so slight that it is without significance.

Males ..... 192 cases	W. B. C. 17,407	Polys. 84.9%	Dispro. plus 2.5
Females .... 117 cases	W. B. C. 16,378	Polys. 83.7%	Dispro. plus 2.4

2. *Age and the Resistance Line.*—The general principle that the younger the individual the better his resistance is well illustrated in this series. It will be noted from the table below and Fig. 1, that the most favorable resistance is offered in the first decade, and gradually becomes less favorable with progressing age. The resistance line gradually changes from a slightly rising line (a disproportion of plus 1.3) in the first decade to a steeply rising line in the sixth decade (a disproportion of plus 7.8).

Age	Number of cases	Average W.B.C.	Average Poly. Per cent.	Disproportion
0– 9	25	19,604	85.9	Plus 1.3
10–19	113	18,298	84.5	Plus 1.2
20–29	76	16,631	84.5	Plus 2.9
30–39	48	15,303	84.8	Plus 4.5
40–49	29	13,659	83.5	Plus 4.9
50–59	13	15,115	84.7	Plus 4.6
60 and over	5	10,266	83.0	Plus 7.8

In Gibson's[32] series of 384 cases over twenty years, there was an average disproportion of plus one, while in 291 cases under twenty, the average disproportion is charted as a horizontal line. Sondern[21] holds that children gave unreliable counts because their polymorphonuclear percentage is a greater variable quantity. Wilson[23] also noted that more exceptions are found in children. Our series shows quite definitely that the best resistance is offered under twenty years of age, and the resistance becomes progressivly less as the age increases.

3. *Temperature and the Resistance Line.*—The temperature used in this analysis was the admitting temperature. The resistance line compares roughly with the temperature in that it changes from a plus 2.1 for temperature between 98° and 99°, to plus 10.5 for cases over 105.° There is a slight variance under 101°, but above this point the disproportion figure steadily rises.

Temperature	Cases	W.B.C.	Polys. Per cent.	Disproportion
98– 98.9	15	13,686	80.7	Plus 2.1
99– 99.9	42	15,230	81.9	Plus 1.7
100–100.9	73	15,836	84.0	Plus 3.2
101–101.9	84	18,990	85.9	Plus 2.0
102–102.9	60	17,582	85.0	Plus 2.5
103–103.9	20	16,585	87.2	Plus 5.5
104–104.9	13	17,300	88.5	Plus 6.2
105 and over	2	17,000	92.5	Plus 10.5

Greenough [3] stated that in a series of cases, the degree of leucocytosis corresponded roughly with the degree of temperature, but individual cases vary greatly, although he gives no data. On the other hand, Mitchell [40] feels that the relation of the temperature to the leucocytosis does not seem to give reliable information, as cases are seen with grave clinical symptoms and high blood counts with little or no temperature. Gibson [32] found in 287 cases which had a temperature of 102° or more, an average white count of 18,000 and 82 per cent. polymorphonuclears, a disproportion of minus 1.0. We find in our series, as can be seen in the above figures, a steadily increasing polymorphonuclear percentage, while the total white count remains approximately stationary after 101°. Attention is called to the rising disproportion figure, shown graphically in Fig. 2.

4. *The Pathological Process and the Resistance Line.*—In an effort to establish a relationship between the pathological process and the blood picture, we have classified our cases in a classification modified from that used by Fowler,[28] as follows:

A. Non-perforated (without pus).
   1. Inflamed.
   2. Gangrenous.

B. Gangrenous with perforation.
   1. Local peritonitis with abscess, pus limited by its position or adhesions.
   2. Spreading peritonitis, limited to the right lower quadrant, or to the lower abdomen.
   3. Diffuse general peritonitis.

And in a further effort to establish the above-mentioned relationship, we have grouped and analyzed 1945 cases recorded in the literature.

In the analysis of our series, there is a very gradual increasing disproportion (with the exception of the spreading peritonitis group) from plus 1.9 in the simple inflamed cases, to plus 8.8 in the general peritonitis group. This is graphically shown in Fig. 3. The analysis of the thirteen deaths occurring in this series shows a rising line of plus 6.0 (note Fig. 6).

Class	Cases	W.B.C.	Poly. Per cent.	Disproportion
Inflamed	138	16,703	83.6	Plus 1.9
Gangrenous	65	18,100	85.6	Plus 2.4
Abscess	65	16,794	84.7	Plus 3.0
Spreading peritonitis	26	17,584	83.3	Plus 0.8
General peritonitis	15	13,223	87.0	Plus 8.8
Total	309	16,921	84.3	Plus 2.4

We believe these figures, and more graphically the chart (3), show in general, a better resistance and consequently prognosis in the less severe pathological processes, while a more nearly horizontal line or rising line indicates a more severe process.

Detailed analysis of our series may be noted on the table; salient points might be mentioned:

(a) Inflamed group: 138 cases, with an average leucocyte count of 16,703, with extremes in individual cases from 5900 to 42,000; an average

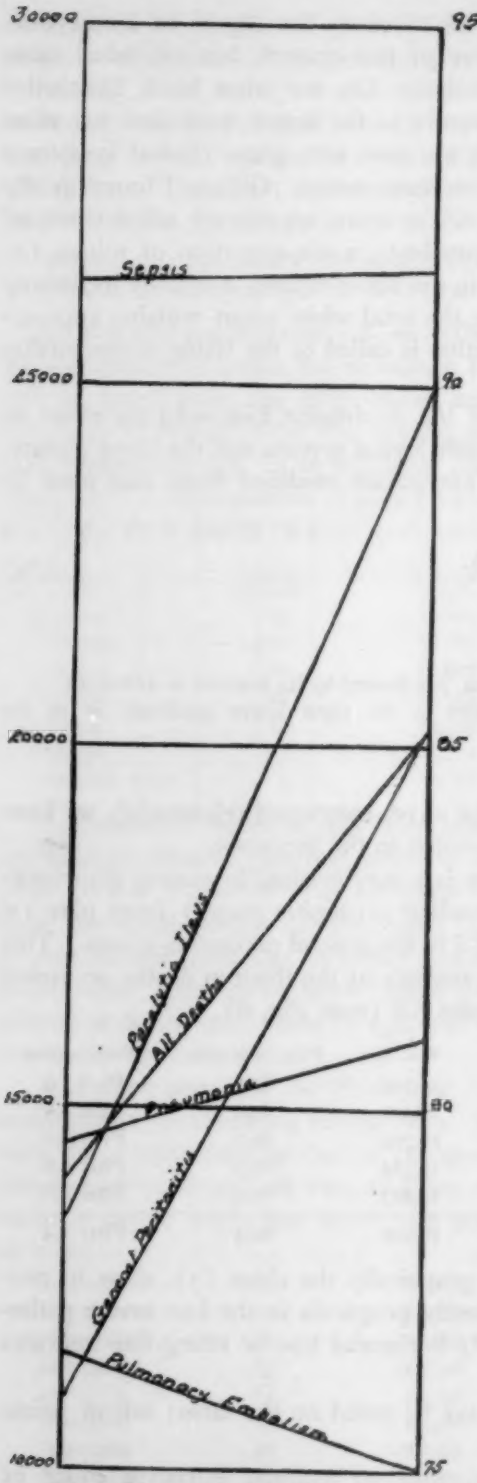

FIG. 6.—Deaths. Resistance line in 13 cases of acute appendicitis.

polymorphonuclear percentage of 83.6, with extremes from 50 per cent. to 98 per cent. The average disproportion is plus 1.9.

(b) Gangrenous non-perforated group: 65 cases, with the highest average leucocyte count of any group, 18,100, with extremes in individual cases from 8000 to 40,000; an average polynucleosis of 85.6, extremes from 66 per cent. to 96 per cent. An average disproportion of plus 2.4.

(c) Abscess group: 65 cases, average leucocytosis of 16,794, with individual extremes from 5000 to 30,000, the former being a large localized abscess; an average polynucleosis of 84.7, with extremes from 68 per cent. to 98 per cent.; and a disproportion of plus 3.0.

(d) Spreading peritonitis group: 26 cases, average leucocyte count 17,584, with extremes from 6800 to 35,200; the lowest average polymorphonuclear percentage of any group, 83.3 per cent., with extremes from 68 per cent. to 98 per cent.; and the lowest disproportion of any group—plus 0.8. It is of interest to note that this group, possibly because it is most poorly defined, should present a polymorphonuclear percentage indicative of the least severe process, while pathologically at operation, the process is found more severe, as a rule, than any of the above three groups. We can not offer a satisfactory explanation for this apparent discrepancy. Stahl has emphasized that it is not the presence of pus that modifies the cell count, but the consequences of the presence of

pus. It would appear that in this condition, the spreading of the process over an increased territory must be less intensified than in the case of a well-developed, though localized abscess.

(e) General peritonitis group: 15 cases, average leucocyte count of 13,223, with extremes from 6500 to 20,000, the lowest average leucocyte count; an average polynucleosis of 87.0 per cent., with extremes from 80 per cent. to 90 per cent., the highest average polymorphonuclear percentage. The disproportion of plus 8.8 is much the highest of any group. Attention is called here to the poor resistance as indicated by the total white count and the severity of the process as indicated by the percentage of polymorphonuclears. Other writers have called attention to this picture, supposing that the rapid spreading of the condition literally overcomes the body's resistance, with this blood picture resulting.

5. *Post-operative Course and the Resistance Line.*—While data were collected on the post-operative course, complications, type and amount of drainage, and post-operative blood counts, we did not establish a definite relationship between the blood findings pre-operative and the post-operative course. We agree with Meleney [42] that infection and contamination have nothing to do with the initial rise, though they will of course maintain the count above normal.

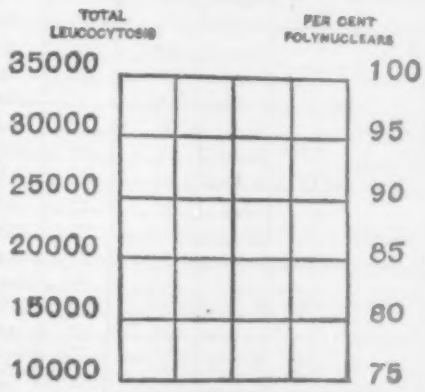

FIG. 7.—Gibson's "Standard Chart." The other charts shown are modifications of this for analytical purposes.

6. *Lymphocytes and the Resistance Line.*—No special attention has been paid in this series to the total lymphocytes, but the work of Holmes,[43] Williams,[44] Mehrtens,[45] and recently Jones and Brown,[35] indicates the lymphocytes are worthy of consideration. The last named investigators hold the total lymphocyte count as a very reliable index of the patient's state of resistance, and closely parallels Walker's index.

7. *The Infecting Organism and the Resistance Line.*—In those cases where an organism could be cultured directly from the pathological condition found, we have collected the data on these cases. Farr [46] has recently collected the data on the infecting organisms with reference to the wound healing, and type of organisms. We have found 64 cases in which the organism was definitely cultured.

Organism	Cases	W.B.C.	Poly. Per cent.	Disproportion
B. coli communis	24	18,308	87.6	Plus 4.3
Gram-neg. bacillus of colon group	25	17,920	85.3	Plus 2.4
B. proteus	10	16,860	85.2	Plus 3.4
Staphylococcus aureus	3	13,600	85.6	Plus 7.0
B. lactis aerogenes	2	13,500	80.0	Plus 1.5

Also one case of each of the following: B. pyocyaneus, staphylococcus albus, streptococcus hæmolyticus, and a non-hæmolytic streptococcus. A large number of cases of mixed infections were also collected, but because of difficulty in an interpretation of such cases, we have omitted them. We feel that not a great deal of significance should be attached to the above findings, since one strain of the same organism may be much more virulent than another strain, and hence be the cause of a more severe reaction. It is interesting to note that

General Averages of Leucocytosis and Polynucleosis of 1945 Cases of Appendicitis

Author	Cases		Chronic	Sub-Acute	Inflamed	Gangrenous	Abscess	Perforated	Spreading Peritonitis	General Peritonitis	Total Average
Fowler (1910)	278	Cases	53	12	38	12	45	—	47	38	—
		Ave. W.B.C.	11150	16500	19200	18700	21300	—	25700	32750	—
		Ave. % Polys	68.75	73.75	86.0	84.3	83.3	—	88.0	86.3	—
Noehren (1910)	69	Cases	—	—	18	11	24	—	4	12	—
		Ave. W.B.C.	—	—	14600	18727	16270	—	23125	18330	—
		Ave. % Polys	—	—	89.3	86.2	890	—	88.7	88.6	—
Pease (1911)	300	Cases	63	—	47	28	14	—	101	47	300
		Ave. W.B.C.	12900	—	14700	19400	22200	—	21000	21800	17063
		Ave. % Polys	680	—	77.0	85.0	88.0	—	88.0	89.0	83.0
Coons and Bratton (1911)	184	Cases	—	—	41	22	62	18	27	14	184
		Ave. W.B.C.	—	—	16890	15545	18677	24038	20072	24678	19094
		Ave. % Polys	—	—	869	884	882	881	87.5	92.5	846
Hewitt (1911)	100	Cases	—	—	35	45		—	20		—
		Ave. W.B.C.	—	—	16652	17817		—	20072		
		Ave. % Polys	—	—	810	873		—	89.5		
Gibson (1910)	Answered 665	Cases	—	—	360	126	156	—	—	33	695
		Ave. W.B.C.	—	—	17000	19000	20000	—	—	19000	18000
		Ave. % Polys	—	—	820	860	880	—	—	950	880
	Did not 30	Cases	—	—	1	7	11	—	—	11	30
		Ave. W.B.C.	—	—	23000	16000	18000	—	—	19000	18200
		Ave. % Polys	—	—	930	860	850	—	—	860	860
Menninger and Heim (1914)	309	Cases	—	—	138	65	65	—	26	15	309
		Ave. W.B.C.	—	—	16703	18100	16794	—	17594	13223	16721
		Ave. % Polys	—	—	836	856	847	—	833	870	843

FIG. 8.—Average leucocyte and polymorphonuclear counts in 1945 cases from the litcrature.

the Gram-negative bacillus of the colon group is associated with the best resistance and staphylococcus aureus with the highest disproportion.

IV. CASES FROM THE LITERATURE.—An attempt has been made by the writers to group the cases in the literature where the investigator has given his data. With the exception of Gibson,[32] every writer has classified his cases only on the pathological findings of the appendix at operation. We have included the data given by Fowler [28] on 278 cases, Noehren [33] on 69 cases, Pease [34] on 300 cases, Coons and Bratton [25] on 184 cases, Hewitt [29] on 100 cases, Gibson [32] on 705 cases, and our own series of 309 cases, a total of 1945 cases. Even in this list complete data have not been given in all cases, and the present writers have taken the liberty to compute the average leucocyte count and the percentage of polymorphonuclears in the cases of Noehren and Coons and Bratton, from the data given by these authors. Because there was some variance in the classification of cases by the various writers, an all-inclusive classification has been used (note Fig. 8), although attention has been paid only to the larger groups—inflamed, gangrenous, abscess, spreading peritonitis, and general peritonitis.

The analysis of the cases in the literature as a group, in general, supports the findings in our own series, in that the relatively poorer resistance is associated with the more severe process. This is graphically shown on Fig. 4. While there is a general increase in both the total leucocyte count and the percentage of polymorphonuclears, the disproportion of plus 0.2 for the inflamed group is raised to plus 0.3 in the general peritonitis group. On closer analysis of the latter group, if the exceptionally high averages of

Summary of Cases from Literature

	Author	Number of Cases	Total Leucocyte Count: Average WBC	Under 10000	10000 to 15000	15000 to 20000	20000 to 25000	25000 to 30000	30000 and over	Polymorphonuclear Count: Ave. Poly.	Under 75%	75 to 80%	80 to 85%	85 to 90%	90 to 95%	95 to 100%	Disproportion Plus or Minus
Inflamed	Pease	97	14,700	11	15	11	7	1	1	77	17	9	7	11	9	0	-2.7
	Nosbora	18	14,500	2	8	4	1	0	0	80.3	4	6	2	5	1	-	+0.4
	Fowler	38	19200	4	13	10	6	2	1	85	2	6	9	12	7	-	-0.2
	Coues & Bratton	61	16800	0	18	16	3	2	2	81.5	3	11	14	12	1	0	+0.1
	Mensinger & Heim	130	16700	10	54	41	19	6	8	83.6	9	13	27	27	20	3	+1.9
	Gibson	360	17000	—	—	—	—	—	—	82.8	—	—	—	—	—	—	Norm.
	Hewitt	58	16402	—	—	—	—	—	—	81.6	—	—	—	—	—	—	-0.6
Totals		677	16465							81.6							+0.2
Gangrenous	Pease	28	19400	2	6	10	6	3	1	85	5	0	6	11	5	1	+0.6
	Nosbora	11	18727	2	2	3	1	3	0	86.2	0	2	3	2	3	0	+0.8
	Fowler	15	18700	1	4	5	4	1	0	86.2	1	1	1	6	6	0	+0.6
	Coues & Bratton	62	15585	4	6	7	5	0	0	84	0	3	9	10	0	0	+3.5
	Mensinger & Heim	65	18100	1	18	23	10	8	2	85.6	2	6	13	24	10	1	+2.3
	Gibson	126	19000	—	—	—	—	—	—	86	—	—	—	—	—	—	+2.0
	Hewitt	Included under Abscess								—							—
Totals		267	18510	—	—					85.1							+1.6
Abscess	Pease	16	22200	1	3	2	4	2	2	88	0	1	5	5	2	2	+0.8
	Nosbora	29	16270	2	2	3	4	3	0	80.0	4	6	4	6	0	0	-1.2
	Fowler	95	21300	7	35	16	23	10	4	83.3	7	13	25	34	14	2	-3.0
	Coues & Bratton	60	18677	1	18	20	16	4	3	82.2	2	15	20	13	2	0	-1.6
	Mensinger & Heim	65	16795	7	17	20	10	4	2	84.7	2	13	15	14	14	3	+3.0
	Gibson	154	20000	—	—	—	—	—	—	84.0	—	—	—	—	—	—	-1.0
	Hewitt	86	17817	—	—	—	—	—	—	87.2	—	—	—	—	—	—	+4.0
Totals		460	19594							86							+1.5
Spreading Peritonitis	Pease	101	21100	5	16	29	29	9	13	88	4	10	16	27	34	8	+1.9
	Nosbora	4	23125	0	1	1	1	1	0	88.7	0	0	1	0	1	0	+0.6
	Fowler	47	25700	2	12	11	8	5	9	88	1	2	11	24	9	—	-2.7
	Coues & Bratton	27	20952	0	7	10	3	4	3	87.5	0	1	5	12	9	0	+2.5
	Mensinger & Heim	26	17684	2	6	9	4	2	1	83.3	0	2	9	5	8	2	+0.8
	Gibson	—	—							—							—
	Hewitt	Included under Diffused Peritonitis								—							—
Totals		205	21581							87.8							+0.8
General Peritonitis	Pease	87	21800	4	11	10	8	3	11	89	4	4	4	19	13	3	+2.2
	Nosbora	18	18330	0	5	3	2	2	0	88.6	0	1	2	6	3	0	+0.3
	Fowler	38	32750	1	12	9	5	9	4	86.3	0	3	3	17	15	0	-0.7
	Coues & Bratton	16	24678	1	0	3	1	6	3	92.5	0	0	0	3	7	4	+2.9
	Gibson	44	19000	—	—	—	—	—	—	85.0	—	—	—	—	—	—	+1.0
	Mensinger & Heim	15	13328	3	0	3	1	0	0	87.0	0	0	4	6	5	0	+0.8
	Hewitt	20	20072	—	—	6	—	—	—	89.5	—	—	—	—	—	—	+4.5
Totals		190	22480							87.7							+0.3
		Chronic Appendicitis															
Chronic	Pease	63	12900	20	23	16	1	3	0	69.0	41	11	8	2	1	0	-6.9
	Fowler	33	11150	10	8	6	0	0	0	66.7	19	8	5	1	0	0	-7.3
Totals		96	12298							68.9							-8.3

Fig. 9.—Summary of total leucocyte and polymorphonuclear counts in cases from the literature.

Fowler are omitted, the remaining 152 cases show a disproportion of plus 3.1. The findings of Fowler in the cases of spreading peritonitis and general peritonitis are much higher general averages than found by any other worker reported, while the average leucocytosis in general peritonitis noted by the present writers is much lower than noted by any other workers.

Pathological group	Number of cases	Average W.B.C.	Average poly. Per cent.	Disproportion
Chronic	96	12,298	68.9	Minus 8.3
Inflamed	677	16,465	81.6	Plus 0.2
Gangrenous	267	18,510	85.1	Plus 1.6
Abscess	461	19,594	86.0	Plus 1.5
Spreading peritonitis	205	21,520	87.3	Plus 0.8
General peritonitis	190	22,480	87.7	Plus 0.3

If the exceptionally high figures of Fowler are omitted from the last two groups, the averages are much changed:

Spreading peritonitis	158	20,270	87.0	Plus 1.8
General peritonitis	152	19,980	88.0	Plus 3.1

V. SUMMARY.—1. Sex: Sixty-two per cent. of our series of 209 cases of acute appendicitis were males; the females showed a resistance of plus 2.4 and the males plus 2.5; Gibson's series parallels these figures.

2. Age: There is a steadily rising disproportion from the first decade to the sixth decade, from plus 1.3 to plus 7.8, so that the resistance line changes from a slightly rising line to a steeply rising line.

3. Temperature: The disproportion index varies to a slight degree under 101°, but from this point steadily increases with the temperature to a plus 10.5 at or over 105°.

4. Pathological process: A general classification for the process found at operation has been used, and cases classified as inflamed, gangrenous, abscess, spreading peritonitis, and general peritonitis. The general trend of the resistance line is to change from a slightly rising line (plus 1.9) in inflamed cases to a very steeply rising line (plus 8.8) in general peritonitis cases. The one exception is the series of spreading peritonitis which shows the most nearly horizontal line.

5. Post-operative course: No definite relationship was established between the course post-operative and the pre-operative blood picture.

6. Lymphocytes: No attempt was made to study the lymphocyte count, though attention has been called to its value by other workers.

7. Infective organism: Data presented on 64 cases where the infecting organism was cultured, show the staphylococcus aureus associated with the highest disproportion (plus 7.0).

8. Literature cases: 1945 cases have been grouped and analyzed on the pathological findings at operation. We find a gradual rise in the disproportion from minus 8.3 for the chronic cases to plus 0.3 for the general peritonitis cases. With the omission of one worker's figures, the results given by six other workers show a disproportion for the general peritonitis of plus 3.1.

VI. CONCLUSIONS.—1. SEX: Females show a slightly better resistance than males, but the difference is so slight, that we do not give it weight.

2. Age: The younger the patient, the better is his resistance. This fact, which is generally regarded as an axiom, is here supported by actual findings, and has been found to hold for all ages.

3. Temperature: The temperature, as shown in a series of cases, is proportional to the polynucleosis and to the resistance index, although it shows slight variation under 101°.

4. Pathological process: The best resistance is offered by the individual against the less severe pathological process. With an extensive process, the body resistance is overwhelmed.

5. Infective organism: The type of organism very probably plays a rôle in the severity of the inflammatory process and consequently in the resistance index, but because of varying degrees of virulence of different strains of the same organism, definite conclusions can not be drawn from the data here presented.

6. We support the principles that the total leucocyte count is a measure of body resistance against an inflammatory process up to a certain degree of leucocytosis; the percentage of polymorphonuclears is an index of the severity of the inflammatory process; and that the greatest aid to be obtained from a pre-operative blood count as to indication for operation, is the relationship of these two, as described in this article.

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LATE RECURRENCE AFTER RADICAL OPERATION FOR CARCINOMA OF THE BREAST*

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In June, 1921, three patients on whom I had done a radical operation for carcinoma of the breast 12 to 16 years previously, came to me on account of the recurrence of the growth, or the fear of it. A few months later I saw in consultation and operated for recurrence a patient who had had a carcinoma of the breast removed 11 years before at St. Vincent's Hospital.

Two of these, presenting themselves 12 and 11 years after the primary operation, had local recurrence. The latter case had also a carcinoma of the opposite breast. One patient had carcinoma of the opposite breast without recurrence in the breast operated on 16 years before. The fourth patient, also operated 16 years before, had no recurrence and no tumor of the other breast, but came to the hospital because of symptoms suggesting a possible abdominal metastasis. Thorough examination, including X-ray, gave no evidence of such a growth, her symptoms cleared up and she was discharged from the hospital. In these patients 11 to 16 years had passed between the primary and secondary operations, hence the time after operation when we can call a patient cured is indefinitely prolonged.

Recurrence, after radical operation for carcinoma of the breast, is the rule and not the exception. The statistics of seven German Clinics, quoted by Ransohoff,[1] showed that 58 per cent. of the cases operated recurred locally, or in the axillary or supraclavicular glands. Of these 22 per cent. occurred after the third year.

The statistics of the results after operation for carcinoma of the breast vary to some extent, according to the percentage of all cases that are heard from, the proportion of gland-free cases and the operator's willingness to operate on advanced cases. They have improved in recent years, but not as much as one would expect, with the improvement of the technic and the use of the X-ray, because more of the advanced cases, in which recurrence is more frequent, are operated on.

Among cases operated by a number of British surgeons, G. P. Mills[2] found a six-year cure in 39.8 per cent. of all cases and 62.9 per cent. of gland-free cases.

Sistrunk[3] found 36.7 per cent. of all cases alive † five to eight years after operation and 64 per cent. of gland-free cases. This shows that Sistrunk's series contained more gland-infected cases, and exemplifies the inaccuracy of comparing statistics.

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* Read before the New York Surgical Society, October 22, 1924.

† Nine had recurrence.

The duration and stage of the growth, the presence of lymphatic involvement, the type of cancer, and the age of the patient influence the ultimate result more than any other factors. Of these the duration of the growth is the most important, for, as Bloodgood [4] says, "If the lump felt by the patient proves to be cancer, its duration is the only controllable factor in the ultimate cure." Also, "The percentage of the recurrences after five years gradually rises with each two-month period of time," between the origin of the growth and the operation.

The type of the radical operation that is employed is of comparatively minor importance, provided the lymph-bearing fascia is thoroughly removed. Of those who lived three years or more after operation at the Massachusetts General Hospital, Greenough, Simmons and Barney [5] found that 19 per cent. developed recurrence. This is the same percentage found by Schroeder in the Rostock Clinic. Halsted [6] found that 20 per cent. of those living over five years after operation had recurrence later on. Among the seventeen recurrences after the third year at the Rostock Clinic, 47 per cent. developed after the fifth year.

A brief history of my patients with late recurrence brings up some interesting questions as to the nature of recurrence and its treatment.

Case I.—Mrs. L. E. W., forty-two years, was operated by me at the Presbyterian Hospital for an adenocarcinoma of the right breast in April, 1909. A lump had first been noticed in the breast two months before. The axillary glands were not involved. She was well for twelve years, until April, 1921, when she noticed a small hard lump in the lower part of the scar, which grew slowly until it was the size of a marble. It was hard and nodular and extended to the inner side of the scar. No lymph glands were palpable. It was removed, under local anæsthesia, June 27, 1921, and the specimen was examined by Dr. James Ewing and pronounced carcinoma. She was referred to the Memorial Hospital for treatment by radiation and from their records I abstract the following. In July, 1921, there was no evidence of any disease and no X-ray evidence of metastases in the chest.

On August 6, 1921 a hard area, 4 by 2 cm., was noted in the right infraclavicular region, which, she said, had been present since operation. Radium pack treatment of the right chest area four times, from August 10 to October 13, 1921, and again on March 19, 1922. On January 16, 1922 a growth was noted in the scar over the fifth rib. Six weeks later this measured about 1 cm. in diameter. In September, 1922, this was noted by the visiting nurse as a small hard tumor in the scar. She did not return to the hospital, the nodule finally ulcerated so that in September and October, 1923 discharge and bleeding were noted. At the latter date she was very weak and died November 3, 1923, about two years and eight months after the appearance of the recurrence. Her death was accelerated by three severe hemorrhages from the vagina, due to sloughing after the use of radium in the cervix, though no new growth was found under anæsthesia. She was greatly weakened and never fully recovered from these hemorrhages. In this case radium did not have a good effect on the breast and a very poor one on the cervix.

Case II.—Mrs. P. F., fifty-five years old, was seen in consultation March 31, 1922, Eleven years before her right breast had been removed for carcinoma by a radical operation at St. Vincent's Hospital. For about two years she had noticed small hard nodules under the skin and the scar of the right breast. These have slowly increased in size and two or three have ulcerated. About a year ago a tumor developed in the left breast, the nipple became retracted and the lump slowly increased. On examination this is hard, nodular and movable on the parts beneath. The left axillary nodes are moderately

enlarged. No supraclavicular glands are palpable. There is an ulceration, 2 by 3 cm., in or near the scar of the right breast and several small hard nodules around this.

On April 14, 1922, I did a radical operation on the left breast and axilla, with Stewart's incision. She was referred to Memorial Hospital for X-ray and radium treatment. Twelve treatments by X-ray and one by radium were given from July 22, to October 23, 1922. In November, 1922 there was no evidence of disease, except three small areas, scabbed over, but an X-ray plate shows evidence of metastases in the chest.

In April, 1923, several small nodules in the skin of the right chest, which had been treated by the insertion of bare radium tubes, had disappeared, leaving one or two small ulcers. No other evidence of local recurrence.

In June, 1923, a node, 2 by 2 cm., was noticed in the right supraclavicular region, which was rayed. Again in September, 1923 one or two small recurrent nodules were noticed in the scar of the right breast. About the end of October, 1923, dullness and diminished breathing were noted in the lower part of the right chest and enlarged glands were felt in the right axilla. She was evidently not doing well and three days later two quarts of a blood-tinged fluid were aspirated from the right chest. An X-ray plate, taken a day or two later, showed thickened pleura, peribronchial infiltration and fluid at the right base. She died in November, 1923.

Case III.—Mrs. K. C., fifty-eight years, entered Bellevue Hospital, June 13, 1921. Following a radical operation for carcinoma of the right breast, which I did in Bellevue sixteen years before, she had had no trouble until three weeks before when she noticed bleeding from the left nipple, without any change in the size or consistency of the breast. One miscarriage twenty years ago, no children, menopause nine years ago. On examination there was a hard indurated mass, the size of a quarter of a dollar, around and including the left nipple. The surface was ulcerated, with a sloughy base. The nodule was movable. No nodes were palpable in the axilla.

After operation by another surgeon on the second surgical division, she developed infection of the wound and an abscess was opened and drained. Her resistance was poor, she became septic and died, a little over a month after operation. Microscopic examination showed adenocarcinoma. Axillary nodes showed no involvement.

Case IV.—Mrs. M. R., sixty-three years old, entered Bellevue Hospital, June 8, 1921. She showed the scar of a radical operation for carcinoma of the breast, which I had done at the Presbyterian Hospital, sixteen years before. Since then she had had a pelvic operation and a cholecystectomy, respectively six and five years ago. Though she complained of abdominal pain, gas, vomiting, loss of appetite and headache, an X-ray examination was negative, the symptoms cleared up under treatment and the suspicions of an abdominal metastasis were not confirmed.

We may consider the questions raised by the cases reported above, and other similar cases, as they relate to (1) local and regional recurrence and (2) the development of cancer in the other breast.

(1) One striking feature of the two cases of local recurrence reported was the persistence or virulence of the recurrence, when once established. Another, and perhaps a more correct, way of describing it is that the patient showed a lowered resistance. Is this lowered resistance a general process, a diminution of cellular differentiation and hyalinization, which MacCarty [7] thinks promotes post-operative longevity, or is it due to a local weakening or absorption of the encapsulation of the tumor cells?

At a meeting of the American Surgical Association in 1907, and again in 1922, this subject of late recurrence was quite fully reported and discussed. In 1907, Ransohoff [1] reported 37 recurrences developing seven years or more

after operation, of which 26 were clearly local or regional and 11 were doubtful. Without making an exhaustive search of the literature, I have collected more than as many more. Of the total number, 31 were insufficiently located in the report, 51 were local or regional, and 12 were more remote. The time of recurrence after operation ran all the way up to 25 years. Over 45 per cent. recurred between 7 and 10 years after operation. The majority of those definitely located in the reports were in the scar or beneath the skin near it.

Different explanations of these recurrences are given. Ransohoff[1] in 1907 gave as the trend of opinion that they result from cancer cells left at the first operation, which have remained latent. However, he adds in conclusion that he is inclined to believe that all supposed very late recurrences in the scar are not such in reality, but that some may be a cancer *de novo* in the scar of an old breast operation. This would be a pathological anomaly, for, after a radical operation, the scar itself and the neighboring tissues do not contain the cellular elements that produce a tumor like carcinoma of the breast.

In the discussion of the question at that meeting, Rodman said that "it would seem also that at least a few of these cases of late recurrence are not recurrences at all. One must demonstrate in every case that the histological type of the secondary growth corresponds in every way to the primary."

However, if the secondary growth corresponds to one of the types of breast carcinoma, it must be a recurrent growth, for, after a radical operation, there is no tissue in or near the scar from which such a growth could originate. In my opinion these local recurrences in the scar or beneath the neighboring skin, probably originate in the lymphatics of the underlying fascia, which have been permeated, as shown by Handley in his book on cancer of the breast.

This is borne out by a statement of Judd's [8] that "Recurrences in the skin occur more frequently where a large amount of skin has been removed, and the fascia saved, than where less skin was taken and a very free dissection of the superficial and deep fascia made." This indicates that the superficial nodules develop from the lymphatics in the fascia and not in the skin. This has a bearing on the treatment of recurrent nodules, which should be more radical than is customary. The deeper structures should be removed, and not the nodule merely, in order to remove the source of the secondary growth and of possible later recurrences. The failure to so remove recurrent nodules may account for some of the poor ultimate results, as in Case I, reported. Another inference from the above is that greater care should be used in the primary operation to remove the lymph-bearing fascia.

An interesting light is thrown on late recurrences by a German case, referred to by Curtis,[9] where at autopsy, five years after removal of a breast, several cancer cells in a quiescent condition, *i.e.*, with no mitoses, were found in the deeper glands of the axilla.

As to the other question, suggested by these cases I have reported, the

occurrence of cancer in the other breast, it might seem at first sight that here there was an independent new growth.

E. S. Judd [8] states that the opposite breast is involved in 10 to 12 per cent. of late cases. Hubbard [10] also says that secondary growth in the opposite breast occurs in a little over 9 per cent. These figures are far above the normal incidence of breast cancer at the cancer age. A. R. Kilgore,[11] in studying the incidence of cancer in the second breast after radical operation, examined 1100 histories, in 659 of which the result for three years or more was known. In this series both breasts were involved 37 times. Both breasts were involved when the patient presented herself in 13 cases, but in most of them the history suggested that cancer originated in one breast and metastasized to the other, rather than that it occurred simultaneously and independently in each breast. Cancer rarely arises simultaneously in both breasts, but the tumor in one precedes that in the other in its origin and development. Kilgore found that if a patient, who has had one breast removed for cancer, survives five years, she is from three to four times more likely to develop cancer in the second breast than a normal woman of the same age in either of her breasts.

This again shows that there is something more than the normal incidence of a second independent new growth.

How does the cancer reach the opposite breast? Bianchetti [12] gives four possible paths. Metastasis, or emboli, in (1) the blood or (2) the lymph. (3) Contiguity. (4) Permeation. As E. S. Judd [8] says, "Embolism is necessarily an impartial process in which all organs are liable, but cancer is by no means impartial."

Some of the lymphatics which emerge from the breast cross the midline and join those of the opposite breast and even pass to the opposite axilla. Thus Moschcowitz [13] reports a recurrence of cancer in the opposite axilla 14 years after amputation of the breast. In a permeation of the lymphatics which anastomose with those of the amputated breast we have an explanation of the involvement of the second breast. This permeation may be stimulated into activity, resulting in the formation of a cancer in the second breast, by various stimuli, soon after the development of the first cancer or at a later period, up to 25 years or more. This stimulation of the latent permeated lymphatics is best illustrated by pregnancy, and is brought out in a paper by H. H. Trout.[14] Only 31 of his 173 cases were under forty years of age, and of the 29 of these that were traced, only 2 had become pregnant, but both developed cancer in the remaining breast. Of the 106 patients over forty years, who were traced, only 9 developed cancer in the remaining breast. As a result of a questionnaire, answered by 46 surgeons, only 15 instances were reported where pregnancy occurred after removal of one breast for carcinoma. Thirteen out of these 15 developed carcinoma in the remaining breast and 12 of them died very promptly, as cancer of the breast, associated with pregnancy, is apt to be rapidly fatal. The interval between the first operation and the recurrence with pregnancy varied from two to ten years.

It seems quite evident that there was something left, in or near the breast, from the first carcinoma, that was responsible for the development of the second carcinoma in nearly 87 per cent. of the cases where the breast was stimulated by pregnancy. In other words, one can not escape the conclusion that it was a recurrent growth.

On considering the many instances and forms of late recurrence of cancer of the breast, some would say with Jordan[15]: "In view of such experiences it may well seem a question as to whether we are ever justified in pronouncing a patient cured after operation for carcinoma." This is a somewhat too pessimistic attitude to take.

Is there any hope for better results in the future? I think that we can safely say yes, by the aid of the post-operative, and perhaps the pre-operative, use of the X-ray, given by experts, perhaps using the more intensive penetrating rays, but with due regard to the skin tolerance dose. This treatment has not been in use long enough to enable us to judge of its results by statistics. But the less intensive radiation has given encouraging, though not uniform, results, so that there has been some difference of opinion as to its value. The lack of uniformity is partly a matter of the X-ray operator and the machine and partly the stage and extent of the disease. In a paper by B. J. Lee,[16] he says: "Sufficient data have already been accumulated at the hospital (Memorial) to make one feel very certain that post-operative X-ray treatment prevents certain recurrences and postpones the appearance of practically all recurrences." He also shows that the treatment of recurrence by irradiation prolongs the life of the patient very materially. Gibbon,[17] in 1922, said that the results, much better than 10 years ago, are due to the post-operative Röntgen-ray treatment. In a recent paper Summers[18] says: "Irradiation, if a sufficient dose is given, results in destruction of pathological cells and their replacement by fibrosis; it also results in hyalinization. Hence it is rational." For when fibrosis or hyalinization are present after operation, especially if both are present, life is prolonged very materially, according to MacCarty.[7]

All cases should have an X-ray of the chest, spine and upper half of the femur, as emphasized by Levin,[19] to determine whether there are any internal metastases in the chest or those bones, that are quite commonly involved. In case there are such metastases the radiotherapy should be directed to these, as well as to destroying all possible foci of local or regional recurrence.

Résumé.—There is no time limit to the occurrence of recurrences. Recurrence is the rule and not the exception, but the ratio decreases in proportion to the time after operation.

Irrespective of the time they appear after operation, local, regionary and metastatic growths are recurrences in the great majority of cases. Permeation of the fascial lymphatics accounts for most of the recurrences in the other breast and locally.

The only way of lessening these is by early operation, wide removal of the deep fascia and post-operative radiation.

Early radical operation, before the glands are involved, is still the best treatment, gives the best late results and avoids most cases of recurrence.

The X-ray, with or without operation, is the best treatment of recurrent cases and one of the best means of preventing post-operative recurrence.

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IMPROVED TECHNIC FOR INTESTINAL ANASTOMOSIS

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Intestinal anastomosis is still confronted by the highest mortality rate of any elective operation within the abdominal cavity, owing to: (1) The

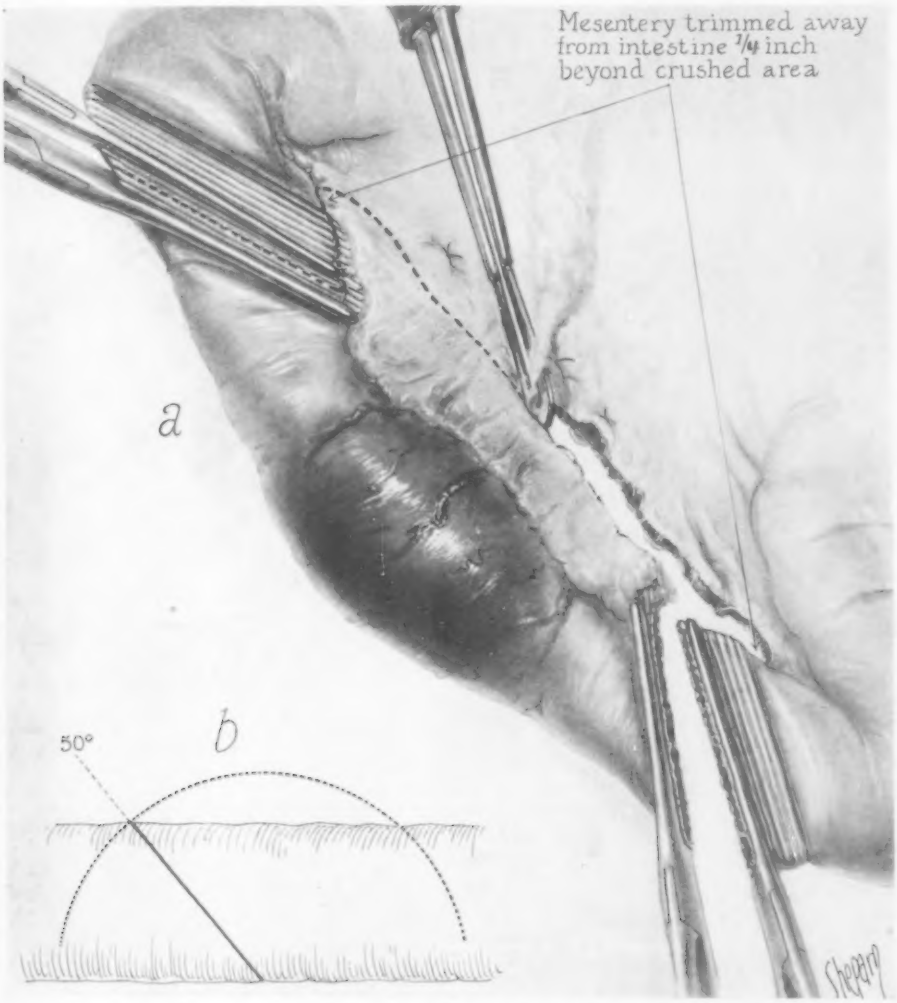

Fig. 1.—The intestine is crushed with a broad Payr clamp, fully one-half of an inch wide, on an angle of about fifty degrees. Thin-bladed Bainbridge retention clamps facilitate later steps. The cautery should not be used to excise the mesentery from the intestine as indicated at the arrow points in the illustration.

lack of aseptic technic, enhanced by the pre-operative morbidity; (2) leakage; (3) secondary obstruction in the area of the anastomosis; and (4) hemor-

rhage into the lumen from the mucosa. Infection from the technic and from leakage are the most frequent causes of failure. From the number of articles constantly appearing, offering as many modifications, it is evident that

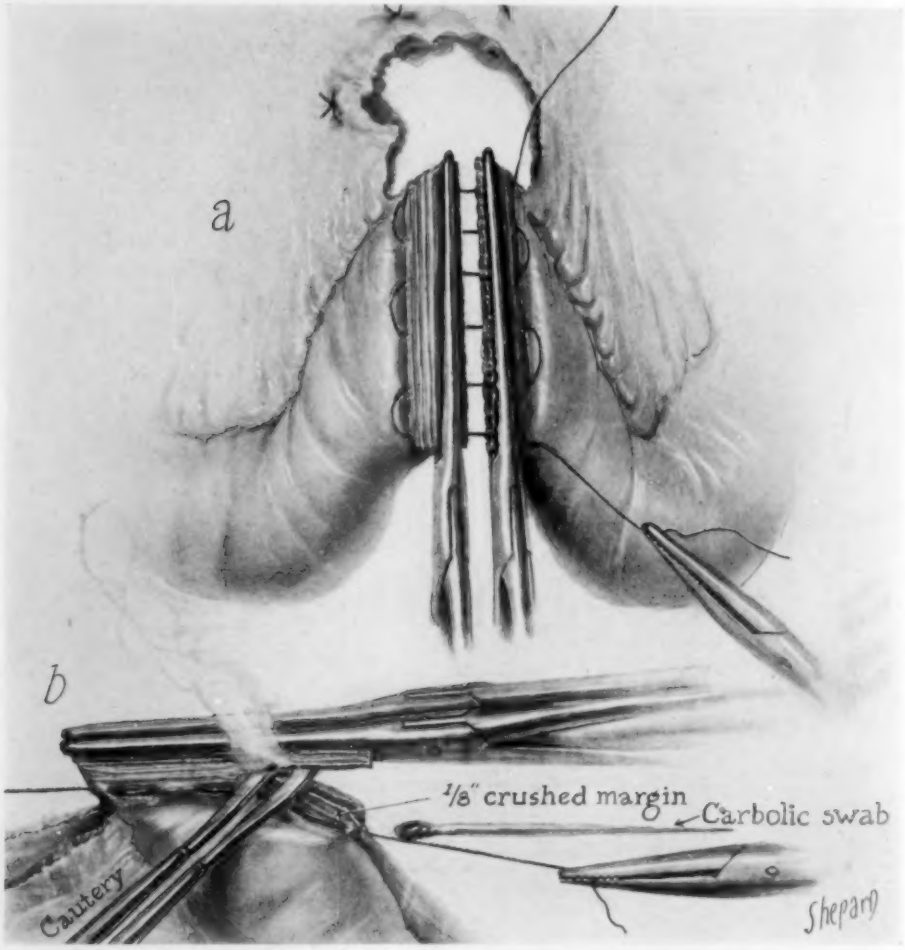

FIG. 2.—(a) The retention clamps are brought together and the linen mattress approximating suture is passed through both segments, exactly where the crushed tissue joins the normal intestine. The suture, however, is held taut as it is passed and the clamps are held closely together during the operation. (b) The distal portion of the linen approximating suture, having become contaminated, is swabbed with pure phenol, and the cuff of crushed tissue is reduced with a cautery to a width of one-eighth of an inch.

a new technic which is simple, aseptic and at the same time preserving an ample lumen, is worth while reporting.

The most frequent causes of death following this operation are from, (1) peritonitis, due to infection, directly from the technic or indirectly from leakage; and (2) secondary obstruction, due to the use of internal appliances or a suture technic which inverts too large a rim of intestinal tissue.

The operation I wish to present has been developed with the primary thought of obtaining, with a suture, an ample lumen under as nearly an aseptic

FIG. 3.—(a) The temporary linen approximating suture is held taut between forceps and the anastomosing suture, of silk or oo chromic, is started on the side opposite to the approximated crushed edges. (b) The anastomosing suture, having completed one side, is continued in order to cover over the one-eighth inch cuff of crushed tissue on the opposite side. Following this step the opening in the mesentery is carefully closed in two layers in order to cover all raw surfaces. (c) After the union has been completed with one layer of silk or catgut, the proximal portion of the linen approximating suture is cut close to the intestine and pulled through. The anastomosis is then opened by inverting the adjacent intestinal walls through it.

technic as possible, realizing that perfect asepsis is an impossibility whenever the lumen of the intestinal canal is opened or penetrated; perfect asepsis and practical asepsis must be appreciated and differentiated. I have gradually evolved this operation, independently, during the past ten years through experimental surgery upon dogs and operations upon man. Its desirable

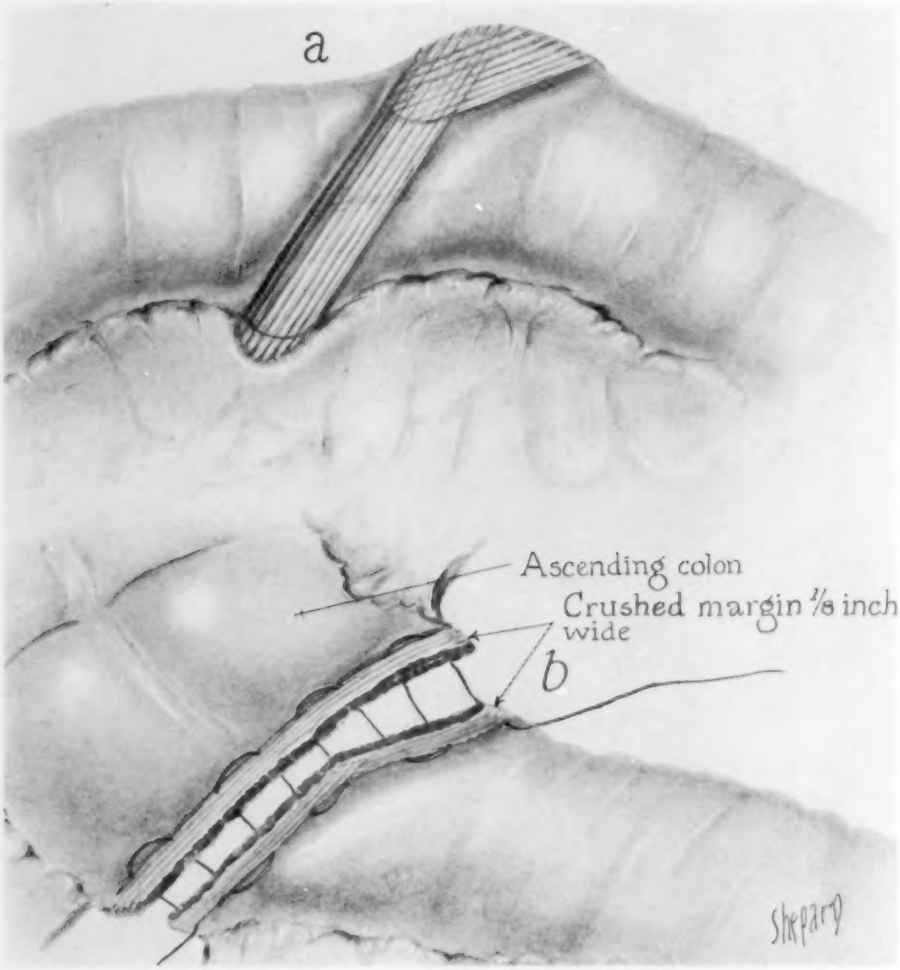

FIG. 4.—A method of end-to-end anastomosis between the large and the small intestine. (a) The small intestine is crushed as illustrated in order to enlarge the opening. (b) The anastomosis carried out as in Fig. 3.

features, with me, have been its ease and rapidity of application, its relatively high degree of asepsis and its resulting large lumen, due to a very narrow rim of intestinal tissue remaining within. It is performed with a single layer of continuous Lembert suture of silk on a fine curved needle, which includes all the coats but the mucosa; a technic I have found, when this single suture is properly applied, is all that is necessary. The intestinal mucosa will not bleed when not sutured, if it is previously crushed and cut with a cautery;

and it will also unite in due time with no secondary ulcer formation. This is not true, however, in gastric surgery.

Technic.—The intestine is crushed three- to four-eighths of an inch wide, on an angle of about fifty degrees; a broad sawed-off Payr clamp makes an ideal crusher (Fig. 1). A long narrow-bladed clamp is applied in the crushed area adjacent to the segment to be resected and another similar clamp placed closely parallel with it; which leaves, for a later step, fully one-fourth of an inch of crushed intestine proximal to the remaining clamp (Fig. 2). The narrow-bladed Bainbridge clamps are used in order to facilitate later steps. The intestine is then amputated with a cautery, and the clamps remaining on the segments to be united are brought closely together (Fig. 1). One continuous mattress suture of fine linen (linen is preferable because it slips through tissues readily) is then passed through both segments, along the edge of the crushed tissue, where it adjoins the normal intestine (Fig. 2A). This linen approximating suture becomes slightly contaminated as it passes through the crushed intestine, but is easily sterilized with a swab of pure phenol (Fig. 2B). This is the only step of any danger and can be safeguarded by simple isolation with packs, and the use of phenol on the suture. We now have the ends of the segments to be anastomosed closely approximated by the single temporary linen suture held taut between two forceps; and distal to the suture we have superfluous crushed tissue which is again amputated with a cautery to within about an eighth of an inch from the linen suture line (Fig. 2B). This leaves a rim of crushed intestine only one-eighth of an inch wide, which is inverted by a single layer of Lembert anastomosing suture of fine silk (Fig. 2B). The anastomosing suture, using the linen approximating suture as a pivot, must be very accurately and uniformly passed entirely around the approximated segments and through the very edge of the uncrushed intestine (Fig. 3). I have found that if the suture is started on the side opposite to the approximated crushed edges, the procedure is greatly facilitated (Fig. 3A). After the anastomosis has been completed (Fig. 3C) the temporary linen suture is cut and pulled through, leaving the crushed edges still obstructing the joined segments. The index finger and thumb then invert the intestinal walls through the rim of the Lembert suture, opening the anastomosis, which will be found to have a lumen amply sufficient. Soft clamps are occasionally applied on the intestine about three inches away from the resected ends in order to retain intestinal contents; however, this is generally unnecessary.

The small intestine is frequently anastomosed, end-to-end, to the large intestine, and I have found that by increasing the length of the crushed area in the small intestine, as in Fig. 4, the operation can be carried out in the same manner as above. Again in this operation the main point in technic is the suturing which must be planned to invert as little intestinal tissue as possible. The illustrations with their legends are far more explanatory.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 8, 1924

The President, Dr. Eugene H. Pool, in the Chair

TRANSPLANTATION OF TOE FOR CONGENITAL ABSENCE OF FINGER

Dr. Harold Neuhof presented a child, now nine years old, who when seven years of age was admitted to Mount Sinai Hospital in July, 1922, complaining of deformity of both hands, dating from birth. Except for these deformities she was a healthy child. On the right hand the thumb, fourth and fifth fingers are normal, the terminal phalanx of the index finger is missing and practically the entire middle finger. The left hand showed fused stumps of the last three fingers, a normal index finger with constricting bands, and a stump of a thumb. In order to test the quality of repair and to separate the stumps a plastic operation was done on the fused fingers of the left hand. The tissues healed very kindly.

The plans for transplanting the second toe for the absent middle finger of the right hand were then made. By trying various positions it was found that the most advantageous position was obtained by approximating the right hand to the left foot, hence several days prior to operation a plaster-of-Paris casing was made with the child in that position in order to hold her so after operation.

August 1, 1922, the first stage of the operation was carried out. The finger stump was first prepared. A flap with its base on the ulnar side of the stump was turned down, the bone which was cartilaginous in consistency was exposed and its end freshened, the flexor and extensor tendons were freed. The preparation of the toe was as follows: The web between the first and second toe was divided, the incisions extending well up on the dorsum and sole of the foot. To obtain length, it was decided to use part of the metatarsal. One and a half cm. of that bone was exposed and the flexor and the extensor tendons were divided at this level. All the tissues on the outer side of the toe were left intact as it was hoped that the blood supply would be furnished from this side. The skin on the opposite side was undermined slightly to provide for suturing to the skin of the finger, the metatarsal was divided at a point about 1½ cm. from its distal end. The hand was now brought down to the foot, the fingers interlaced with the toes, the flexor and extensor tendons of the finger were united with those of the toe with silk sutures, one chromic suture was used through the bones to approximate them, the skin edges united with horsehair. The child was placed in the plaster casing and the position further maintained by reënforcing with adhesive plaster strips. In her reaction from the anæsthetic the child struggled, and when on the third day the wound was inspected, there was found some separation of the skin edges. These were again approximated and held by means of adhesive plaster.

About twenty-one days later the second stage of the operation was completed. Incisions were made extending well up on the dorsum and sole of the foot between the second and third toes. In the manipulations of detaching the toe it was believed that the extensor tendon suture line was

compromised. It was found also that the head of the metatarsal which was to have been used made too great a bulge in the palm of the hand, so that part of the bone and some excess fat was discarded. The skin was sutured with horsehair. The foot wound was strapped with adhesive.

The day following the operation all dressings except one layer of gauze were removed and the hand kept under a cradle with one electric light continuously burning. The transplant healed very kindly. Sensation began to return after three weeks. X-ray examination made three months later showed the architecture of the bone in the transplant to be normal. Function was limited to slight flexion and extension. The cosmetic result to-day is good, the function is still limited, there is complete sensation, and the X-ray shows the bone to be normal. There has been distinct increase in the length of the finger.

BRONCHOSTOMY FOR BRONCHIECTATIC SUPPURATION

Dr. Harold Neuhof presented a woman, who was twenty-two years old when admitted to the medical service of Mount Sinai Hospital in September, 1922, complaining of cough, fever, profuse foul expectoration and hæmoptysis. Because of frequent sore throat she had had her tonsils removed under general anæsthesia three months before admission. Two days after the operation she noted pain in the right chest which radiated upward toward the right shoulder. Forty-eight hours later she had fever. Some time during the second week she began to have profuse purulent expectorations which were blood streaked. This continued up to the time of her admission to the hospital, although there were free intervals when she was afebrile and felt comparatively well.

The patient when admitted had a temperature of 99° and showed on examination dulness with diminished breath and voice sounds and few crepitant râles over the middle lobe, right side. X-ray examination showed infiltration of the middle lobe. During her four months' stay in the hospital she had an effusion at the right base which was spontaneously absorbed, and at times with accession of fever increased signs in her chest which pointed to a spreading pneumonitis. There were several hæmoptyses. Sputum varied up to eight ounces a day and was repeatedly negative for tubercle bacilli. Bronchoscopy showed pus coming from the middle lobe bronchus and there was found one point just at the spur which bled easily and which was cauterized with silver nitrate. The patient was finally discharged, improved, having gained ten pounds in weight.

Five weeks later after several severe hæmoptyses and with profuse foul sputum up to eight ounces a day, she was readmitted, this time to the surgical service. The physical examination was as on previous admission, but this time clubbing of the fingers was noted. X-ray seemed to show involvement of the upper as well as the middle lobe. On January 15, 1923, a thoracotomy and drainage of a bronchiectatic abscess was done. In local anæsthesia 6 cm. of the second rib was resected subperiostially, after which the posterior layer of the periosteum was excised. Through this limited exposure it was seen that the middle lobe was the seat of an infiltration and that the free pleural cavity was sealed off. Repeated aspirations were negative, therefore about 6 cm. of the third rib was removed in a manner similar to the second. Again aspirations were without result. Returning to the second space a little foul fluid was drawn up into the syringe, the lung was entered at this site and partly under guidance of the eye and partly the finger, a dilated bronchus was entered. Three days later it was noted that a good fistula was present, the sputum rapidly decreased to zero. During convalescence an abscess of the thigh developed, which was drained. The bronchial fistula was unfortunately

allowed to close and there was a return of foul sputum with cough, and finally hæmoptyses. The patient was discharged, to be treated by bronchoscopy.

After her discharge she felt well for a short time, but after four months was readmitted with her old complaint. On this admission the X-ray examination seemed to show involvement of the lower lobe. Therefore an exploratory thoracotomy was done, entering the chest by a long resection of the seventh rib. With the exception of one adhesion of the lower lobe to the diaphragm nothing pathological was noted. The chest was closed without drainage. A few weeks later she was discharged to return for further procedures on the upper lobe.

Her fourth admission was six weeks later. At this time the X-ray showed involvement of the upper and middle lobes with several small cavities in the middle lobe. Bronchoscopy again showed that most of the pus came from the middle lobe bronchus.

Operation was again undertaken at the site of the first operation. It was begun in local anæsthesia, but when it was found that a very extensive procedure would have to be carried out, general anæsthesia was given. The old scar was excised and further sections of the second and third ribs removed. Aspirations were without result. It was then felt that the lesion was near the hilum and in order to properly expose this portion of the lung the upper and the middle lobes had to be mobilized. This was accomplished extrapleurally, gradually working around posteriorly and above the apex. When the hilum was exposed aspiration revealed 5 c.c. of foul pus, a rather larger amount than was to be expected, and a large bronchiectatic cavity was entered and drained. As an additional measure packings were so placed extrapleurally that the mobilized lobes were compressed, with the idea of an additional aid in overcoming the infection. The post-operative course was stormy with signs of a pneumonia in the opposite lung. On the twentieth day the patient was discharged with the packings and drain in place. At this time the purulent sputum had entirely ceased, there was but slight cough, and no fever.

The bronchial fistula that was established was maintained for eight months, at which time in addition to being symptom-free the X-ray examination of the chest showed the lungs practically clear. The fistula was then allowed to close. It is closed now about four months, there has been no return of symptoms and the patient appears well. Clubbing of the fingers has disappeared. The patient weighs as much as she did before the illness began. It is now one year since the last operation and, in the absence of any symptoms referable to pulmonary suppuration in this long period, it can be assumed that the patient will remain well.

EXCISION OF BILATERAL PARAFFINOMA OF FACE

Dr. Harold Neuhof presented an adult woman who, following an accident which left depressed scars on both sides of her face, had paraffin injected seven years ago. The immediate cosmetic result was good, but somewhat later there was migration of the paraffin and further depression of the scar. About five years ago she began to note trouble in opening her mouth. This interference with function has been progressive until at the time of her admission to the hospital the teeth could be separated for a distance of only 1½ cm.

Examination of the face showed the depression of the scars with a lumpy deformity, the masses extending up over the malar bone and down almost to the ramus of the jaw and deep in the soft tissues. The limitation of function was so extreme that only fluid nourishment could be taken.

Operations were done on one side at a time with a six weeks' interval. The first operation was performed in June, 1924. The procedure and pathology was similar on the two sides. A transverse incision was made parallel to the facial nerve. Excessive bleeding resulted when an attempt was made to free the mass from the overlying skin, so an incision was made through the mass which consisted of paraffin and soft tissues of the face, down to the buccal mucosa, and working from within the mass was not enucleated but literally cut out. In order to obtain closure of the wounds, extension of the incisions had to be made and a plastic repair was done. With the exception of some oily discharge the wounds healed in a normal manner. On one side the facial nerve was injured. While all of the paraffinoma which could be removed was excised, it is not believed that it is all out, as paraffin infiltrated tissue could be seen extending up under the zygoma.

The present scars are no greater than the original ones and the cosmetic result is a great improvement. The functional result is good. The mouth can now be freely opened, although there is as yet far from full freedom of motion of the jaw. There has been progressive improvement since operation and, with the absorption of cicatricial tissue in the operative fields further improvement can be anticipated. No apparatus was employed to stretch the jaws after operation.

Dr. Walton Martin said that it is misleading to refer to these cases of paraffinoma as if they were tumors. They are really infiltrations of cellular tissue with warm paraffin and in operating for their removal difficulties are encountered, dependent on this fact.

The infiltrated cellular tissue must be excised. It is usually impossible to shell out a well-defined foreign body. He referred to a patient he had seen several years ago with such a paraffin infiltration in the cheeks and in whom the removal undertaken by Doctor Pool had been very difficult.

Dr. John Douglas remarked that in two cases he had seen there was marked telangiectasis of the skin over some of the injected areas which made a bad deformity. Both of these patients were women who had had injections above and in front of the clavicles as well as on the face. In four or five years these became infiltrated and there was present areas of subcutaneous scar tissue that had small globules of paraffin throughout them. In one patient they ulcerated on both sides. In this case an attempt was made at dissection, the operation lasting over two hours one day on one side and again a week later on the other side. After the dissection in this case there was lack of healing. On questioning, the patient denied syphilis, but a Wassermann examination was done, and there was a four-plus reaction. She was given salvarsan and other anti-syphilitic treatment and healing followed. The other woman had a telangiectic deformity also, but so far without ulceration. She refused operation.

Dr. Henry H. M. Lyle said that the pathological condition as described by Doctor Martin was found in a great majority of cases, but that he had encountered a few cases in which the paraffin had remained as a simple plaque. This condition he had found in one case underneath the breast and a second one from the groin.

SUBCLAVIAN ARTERY ANEURISM—LIGATION OF INNOMINATE—RECOVERY

Dr. Frank S. Mathews presented a man, sixty years of age, who was operated on by him eight years ago for subclavian and innominate aneurism. The patient had had syphilis twenty years before. An aneurism had been noted for one year above the right clavicle. Pulse of two wrists equal. Pressure in the two brachials 115 and 130. Right carotid pulsated strongly in the neck. The aneurism terminated abruptly at the beginning of the axillary artery. It was fusiform and extended half-way up the neck, making a sharp turn downward beneath the scalenus muscle. At operation on division of the scalenus, a narrowing of the vessel was apparent with a dilation beyond, continuing downward toward the innominate as far as could be felt. The pneumogastric nerve was recognized as it crosses the subclavian at a point where the vessel was twice the size of a thumb. The thyroid axis was not seen. Evidently the portion of the vessel chiefly dilated was the second and third portion of the subclavian. The operation was performed through an incision along the clavicle for almost its entire length. From its middle an incision extended vertically upward. The omohyoid and most of the sternomastoid muscles were divided. The clavicle was sawed in two about its middle. An inch of the inner segment was removed. On retraction downward, the region of the first rib was well exposed. A double chromic ligature was placed on the apparently normal first portion of the axillary artery. In the narrow portion of vessel lying under the scalenus, between the dilated subclavian and innominate, a strip of fascia lata was wrapped three times, so as to practically obliterate the pulsation in the subclavian. The ends of the fascial suture were fastened with chromic gut. The ends of the divided clavicle were approximated by kangaroo tendon sutures. The patient has been practically well and able to follow his occupation as a tailor ever since. There is no pulse in the right radial artery and the union in the clavicle is shown by X-ray to be fibrous. The heart is large and there is a shadow in the upper mediastinum which would indicate a dilated aorta. He has never had a sufficient amount of anti-syphilitic treatment.

THE INDICATIONS FOR OPERATION IN THE TREATMENT OF TUBERCULOUS CERVICAL LYMPH GLANDS

Dr. John Munn Hanford read a paper with the above title, for which see page 885.

Doctor Hanford presented, as illustrating his paper, a woman, twenty-five years of age, single, who was first seen in the Presbyterian Hospital in September, 1922, with a painful swelling in the left side of her neck of two weeks' duration. She had had operations for abscesses in the left side of her neck eight years and four years previously. As a child she had had a congenital dislocation of the left hip. Two operations were done at the New York Hospital, in 1914 and one in 1917. Incision and drainage was done in each case for tuberculous abscesses of the neck. There were no tuberculous nodes present at this time. The abscesses contained about two drams of thick odorless pus. Culture of this pus at the New York Hospital was sterile in broth, for five days. She has been generally well except for the left neck and for a chronic otitis media on the left side with, probably, at one time, a mostoiditis as evidenced by the present X-ray findings of the mastoid. The blood count has been normal; the urine, normal. Wassermann has been negative. X-ray examination of the cervical region in 1922 showed evidence of calcification indicating a probable tuberculosis. In September, 1922, at the

Presbyterian Hospital, incision and curettage of a tuberculous abscess at the same region in the left neck was done and the pathological report was "tuberculous granulation tissue, infected." The culture of the pus was again sterile. Since that time the sinus has never healed. She has been seen frequently; has had twenty-six X-ray treatments to the left neck between November, 1922, and July, 1924, small doses, with an interval of about two weeks. The only focus of infection found that might affect the left cervical lymph-glands was the chronic otitis media on the left side. Tonsils have been removed. In April, 1923, the same region was again operated upon at the Presbyterian Hospital. The scar was excised and abscess cavity was curetted. Again the tissues showed tuberculosis.

The reason for not attempting a complete excision was that the scar tissue of the previous disease and previous operations had probably so involved the eleventh nerve that excision might damage the nerve and give distressing paralysis of the sternomastoid and trapezius muscles. But the neck has never healed.

In January, 1924, another operation was done which consisted of excising the sinus as much as possible and of curetting the depth of the sinus of looking for a foreign body and of trying to determine the direction of the tract. This time the tissue did not show tuberculosis. Following the operation, she had considerable hemorrhage from the wound, probably from a large vein in the region. In April, 1924, the tonsils and adenoids were removed, but no evidence of tuberculosis was found in them. During the past few months there has been no change. Recent X-ray of the mastoids show the right to be apparently normal while the left indicates an old sclerosing process. In August, some 12 per cent. sodium iodide solution was injected into the sinus with the idea of showing up the tract in an X-ray film, when suddenly the patient tasted the salty fluid in her mouth. The X-ray film, however, with this and with bismuth has not outlined anything but a thin streak running from the skin opening into it. Doctor Babcock subsequently examined her and found that the lateral neck sinus communicated with the mucous membrane of her naso-pharynx in the fossa of Rosenmueller. He found no evidence of any primary infection of the nose, throat or sinuses, but did find discharge coming from the tract into the nose. His opinion was that it was probably a branchial cleft remnant with a secondary tuberculous infection which he thought would be very difficult to remove or cure by operation.

Dr. Charles N. Dowd expressed his appreciation of the careful and valuable work which Doctor Hanford is doing, also concurred with him in his conclusion, that radical removal is the most desirable treatment, when it can be suitably accomplished. The subject seemed, to the speaker, to have several topics which are noteworthy.

First, the problem of the eleventh nerve—the fear of injuring this nerve seems to be the main reason for avoiding operation, or for doing partial instead of complete operations. Injury to this nerve can be avoided in almost every instance. There certainly seems to be no reason for leaving enlarged lymph-nodes in the area marked six after the area marked five has been cleared, for in the proper clearing of area five, the nerve is exposed and after such exposure, there is little likelihood of injuring it. Doctor Hanford has referred to the results in 452 Group 1 cases which Doctor Dowd reported in 1916 with an apparent cure of 91 per cent. In nearly all these cases the

entire bunches of lymph-nodes, including those in localities five and six and down the jugular vein, were removed. The technic of the procedure for these early cases was published in the ANNALS OF SURGERY, in August, 1908, and pictures are there given, which show the location of the nerve and the way of avoiding it. After the enlarged nodes have been properly exposed, the capsule of the most prominent node is grasped in toothed forceps; traction is then applied and the adherent tissues about the node are pushed away from its capsule with curved scissors; when some particularly adherent strand prevents blunt dissection a nip of one-sixteenth inch often liberates much adherent muscle or lymph-node, or even vein, as the case may be. During this dissection the course of the nerve may be well located by finding with the finger the transverse process of the atlas; for the nerve, after its emergence from the jugular foramen, is close to this process. It then runs downward, backward and outward until a part or all of it passes into the sternomastoid muscle. It sometimes is included by the various enlarged nodes and this constitutes one of the reasons for careful blunt dissection and the separating of adhesions or of individual nodes as above described. After the most prominent node, the so-called tonsillar node has been removed in this way, the nerve is usually seen for about one inch of its course. When it has thus been located, the rest of the nodes in the sub-mastoid and sub-parotid regions and those in the internal jugular chain can be removed without likelihood of injuring the nerve. This fear of injuring the nerve reminds one of the apprehensions which formerly existed with regard to the facial nerve in the mastoid operation. The fear of injuring this nerve held mastoid surgery back for many years. However, with better anatomical knowledge, these operations are now done in great number and the nerve is seldom injured.

A warning should also be given against injuring the eleventh nerve at the anterior border of the trapezius, a little below the middle of the neck, before its entrance into that muscle. At this point, the lymphatics, the branches of the cervical plexus and the terminal part of the eleventh nerve, lie in close apposition. The lymph-nodes are frequently enlarged here and in removing them the nerve has sometimes been injured, and a corresponding atrophy and disability of the trapezius has followed. In one instance, Doctor Dowd has known such injury to follow an inch incision, which was made for the removal of a single lymph-node, so superficial that it was supposed to be a sebaceous cyst.

Another topic involves the effect of X-ray treatment on other tissues beside the lymphatics of the neck. Much modern work is done on the theory that the X-ray is harmless. But it is not harmless. Cases of sterility have come to the notice of the speaker, which were most unfortunate. Apparently adequate protection by lead is not always possible; at all events, it is not always obtained. Furthermore, other disturbing effects of the X-ray are sometimes very definite. For instance, one of the speaker's patients had ptyalism, so extreme that the amount of saliva almost led to suffocation. In this instance, the mental effect was so profound that at a later time the buzzing of a bee

suggested the X-ray machine and filled her with terror; and to all appearances she was ordinarily a calm woman with more than the average poise. Again, nausea and a general feeling of depression and weakness are often referred to. The speaker believes that fundamentally the danger of X-ray is greater than the danger of nerve injury.

Another topic refers to the anatomy of the neck lymphatics. This after all is fairly simple. The sub-mental, sub-maxillary, sub-parotid, sub-mastoid and sub-occipital groups form a sort of ring about the base of the skull and they all drain toward the deep cervical chain—the current goes downward and backward. Ascending infection is very rare.

Another topic refers to the duration of treatment. If a patient is kept under treatment for two or three or four years, and if the resources of the family are exhausted in his care, a serious and disturbing condition is created. If the nodes can be removed by operation in three-fourths of an hour and if he can go home in ten days or two weeks and can soon go to school and resume his ordinary activities, there is a great conservation of his health and the resources of the family. The advantage of the short method of treatment is obvious.

Dr. Frank S. Mathews said that the collected cases of Doctor Dowd were mainly cases operated on at St. Mary's Hospital, before the days when tonsillectomies were performed, yet these cases of early tuberculous nodes gave excellent surgical results. It is certain, then, that in children with a discrete focus in the tonsillar group of nodes, the excision of the nodes usually results in cure without removal of the tonsils. On the other hand, at the present time, most of the cases which he sees have had the tonsils removed before they came to him for removal of their tuberculous glands. In most cases the parent has been led to believe that the removal of the tonsils would cause a disappearance of the tuberculous glands. His own experience is that tonsillectomy has no considerable effect on the process in the nodes. Occasionally tonsillectomy has been followed by a prompt breaking down of the tuberculous glands—possibly from a secondary infection. It is his feeling that a circumscribed tuberculous focus in the glands should be first removed, to be followed later by a tonsillectomy if it seems indicated by the enlargement or inflammation of the tonsils. In recent years many less cases of tuberculous glands are seen at St. Mary's Hospital for Children, and those seen in private practice have many of them come from outside the city. He is disposed to attribute the change to the improved milk supply. Several cases have been definitely traced to tuberculous cows. At the moment he could not remember a single case in recent years which had been sent to him before the glands reached the abscess stage. In every such case, he regrets that the operation could not have been performed by a shorter, easier dissection, without skin involvement and with less likelihood of scar.

Dr. Robert T. Morris said that after a number of recurrences of tubercular glands and one or two cases of acute miliary tuberculosis following

operation, he began to consider the question of conservative treatment and went over to see Mosetig-Moorhof's work with injections of iodoform in ether. He found that this could be carried out successfully excepting in very young children. All the patients who could be kept under observation made distinct progress. They had, in addition, treatment for tuberculosis, or for the primary focus of infection. There was always the question of operation for glands in which fluctuation could be felt. In trying to differentiate between bovine and human tuberculosis, it was found incidentally that most of the pus was sterile. Operation was not done except where the skin became reddened and thinned. After evacuation of fluid in such cases, the iodoform treatment was instituted and at once the patients got better continuously. Next, Doctor Morris took up the hyperæmia treatment, and this gave good results. He carried this out by having the patient rest the neck on a hot water bag for ten or fifteen minutes and then on a bag filled with cold water, alternating for an hour or more daily. This is the treatment the speaker depends upon chiefly to-day. Sometimes it requires time, perhaps six months or a year before glands cease to give trouble and not all patients will take this time. In addition he gives tuberculin treatment and general treatment for tuberculosis, climatic and nutritional. With the right sort of environment it is unusual for any sort of operation to be required for infected neck glands, in his clinic or private practice.

Dr. Seth M. Milliken expressed himself in favor of X-ray treatments in these cases. If the tonsils are taken out and the glands do not subside, they are probably tuberculous and can be treated with the X-ray. If they do subside, the source of infection has been removed.

Dr. Hugh Auchincloss thought that one of the things it might be wise to bring forth was that tuberculosis is a non-vascular disease. Every effort, by whatever means it is attempted, should have a return of good nutrition to the tissues as an axiom. By excision of tuberculous tissue wherever it is possible to do so without doing undue harm, well-nourished tissues are brought in contact with well-nourished tissues and conditions made favorable for permanent cure. This is especially true of the so-called cold abscess.

Dr. Edwin Beer commented on the movement now growing to treat these cases conservatively and referred to a recent publication in which it was stated that 82 per cent. of a group of so-called tuberculous glands of the neck had been cured by heliotherapy. Personally, he had not seen such results; nor had he seen such results from X-ray treatment as Doctor Hanford had called attention to this evening. How sure could one be that in the high percentage of cures reported the glands were tuberculous? There would always be some doubt in such cases. Doctor Beer agreed with Doctor Mathews that the frequency of these cases has diminished in the last twenty years and believed it to be due to the fact that many people now use pasteurized, or Grade A milk, and as many of the infections are bovine infections, the

control of the milk controls the frequency of the disease. Whether tonsillectomy should be adopted prior to surgical treatment is open to question because with a wound in the throat suppuration may be induced in the glands. It is wise, however, to take out the tonsils if there is only mild glandular involvement for the tonsil is a portal of entry for the tubercle bacillus.

Doctor Hanford, in closing the discussion, said that he would have to learn to take out the glands without injuring the eleventh nerve. Unfortunately, he had often seen the trapezius muscle paralyzed. He had never seen any harm result from X-ray treatments and he had watched these patients for seven years. On the contrary, the X-ray had been beneficial. The first glands involved are usually in the upper cervical group, but by no means are they always the first. Distant glands are sometimes enlarged as the result of an upper focus of infection. He agreed with Doctor Dowd that a cold abscess was not a contra-indication to excision, if feasible. He agreed with Doctor Mathews that tonsils should not be removed indiscriminately; in all his cases where this had been done it was because the nose and throat man thought it advisable *per se*. But, as Doctor Beer had said, the tonsils are occasionally a focus of tuberculous infection even when they appear normal and, if not removed, may cause further trouble in the neck. Doctor Hanford thought the point should be emphasized among the laity and the medical profession that tuberculous glands should be removed in the early stage; and that it is the physician's responsibility to bring these patients to the surgeon before softening occurs.

CORRESPONDENCE

INTRAVENOUS ADMINISTRATION OF UROTROPIN FOR POST-OPERATIVE URINE RETENTION

EDITOR ANNALS OF SURGERY:

Sir:

In the June number of the ANNALS OF SURGERY, Doctor Mills published his most instructive and careful observations on post-operative catheterization. This is a subject of extreme importance and in all probability most of the surgeons have tried something to reduce its frequent use and avoid its dangers.

I would like to call attention to the use of intravenous administration of urotropin in cases of post-operative urine retention, a method that I have described with other prophylactic and therapeutic indications of urotropin in the Archiv für klin. Chirurgie, vol. cxxv, p. 544, 1923. When urotropin is split into formaldehyd and ammonia, this former, after being in contact for a longer period with the mucosa of the bladder, stimulates the detrusor muscle to contract, and—due to its antagonistic innervation—the sphincter to relax, so that the bladder empties itself. No tenesmus or even burning sensation is felt and among the five hundred injections that I made for various purposes, no hæmaturia was noticed. Ten c.c. of a 40 per cent. solution of urotropin are given intravenously at the time when the patient begins to complain of bladder-distention. In operations on the rectum and pelvis, the injection is given routinely eight to ten hours after the operation. Spontaneous urination follows in one to two, not later than five to eight hours.

In bladder paralysis of hysteric origin, that occur in big wards as an epidemic and may even affect pre-operative cases, we may have failures and every other kind of treatment (standing up, thermophor, opening the tap) is equally useless; suggestive therapy is the most effective. But aside from these cases, urotropin always helps, and as it also acts as a powerful inner disinfectant, working in *statu nascendi* at the site of inflammation, wherever this may be, and inhibiting generalized sepsis as shown by Buzello and myself, it is our best prophylactic measure in operations on the meninges, biliary and urinary tract; as a hypertonic solution it acts as a diuretic too, and being strongly alkaline, works against acidosis.

G. DE TAKATS, M.D.,
University of Budapest.

LARGE, MALIGNANT, FACIAL TUMOR REMOVED WITHOUT HEMORRHAGE BY BIPOLAR ENDOTHERMY AND THE ENDOTHERM KNIFE.

EDITOR ANNALS OF SURGERY:

Sir:

Report is herewith submitted of a large tumor of the upper lip in the belief that it will prove interesting from a pathological standpoint as well as from a surgical point of view.

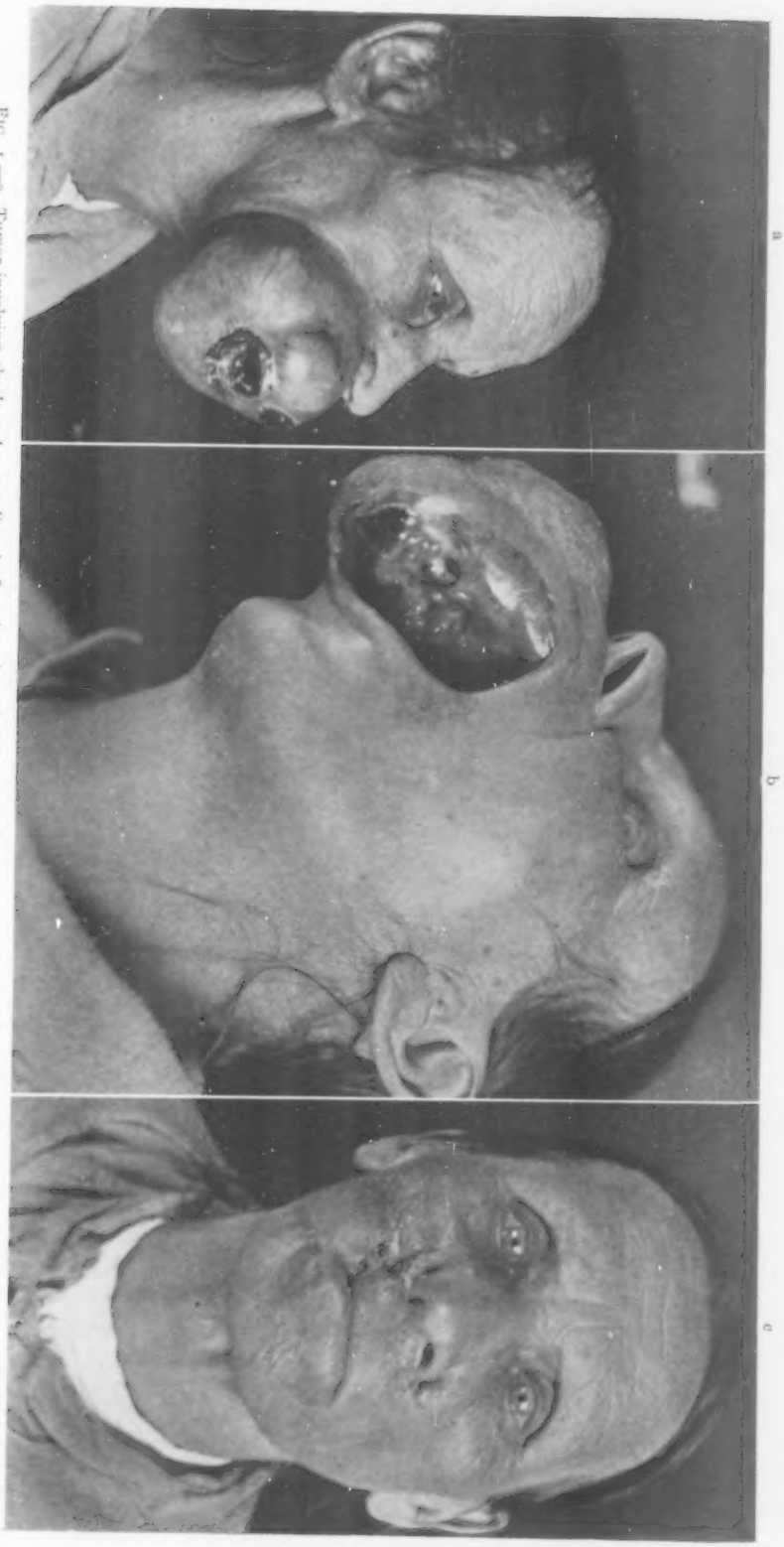

FIG. 1.—a. Tumor involving cheek and upper lip. b. Interior view of mouth showing tumor and crater-like ulceration. c. After plastic repair of lip.

A. G., female, a Pole, aged fifty-eight, was admitted to the Third Surgical Division of Bellevue Hospital, March 4, 1924. At the request of Dr. George D. Stewart the removal of the growth was done, March 13, by the writer with the use of bipolar endothermy and the endotherm knife.

The patient's family history was good, father and mother having died of old age, and two brothers and a sister being alive and well. She was somewhat emaciated and pale but was able to walk around the ward. (Figs. 1 and 2.) According to her report, the growth had begun some three years before as a sore inside the cheek opposite the right bicuspid. Her teeth began to hurt her and she consulted a dentist who said she had a crooked tooth which might be the cause of the sore. This tooth was drawn but the sore did not heal. It remained small for a year when it began to grow larger. During the six months preceding her arrival at Bellevue it had grown very rapidly and at the time I saw her the mass was the size of an extremely large orange. There was no pain or tenderness, but at intervals the tissue would bleed and parts of it would fall away. It involved the right cheek and upper lip, mainly to the right of the midline. The skin was tense and shiny and there were three spots of ulceration. Dilated veins were seen at the upper and lateral aspect of the mass. Externally the growth extended from 4 cm. anterior to the angle of the mandible on the right side around to the point opposite to the first incisor tooth on the left side. Interiorly it extended from the last molar to the midline and there was seen a deep crater-form ulceration which extended to the upper lip. The mass was lobulated and tense. Freely movable, it raised the right ala of the nostril and seemed to involve the tissues of the upper lip and cheek only. There were a few palpable lymph glands on both sides of the neck—more on the right.

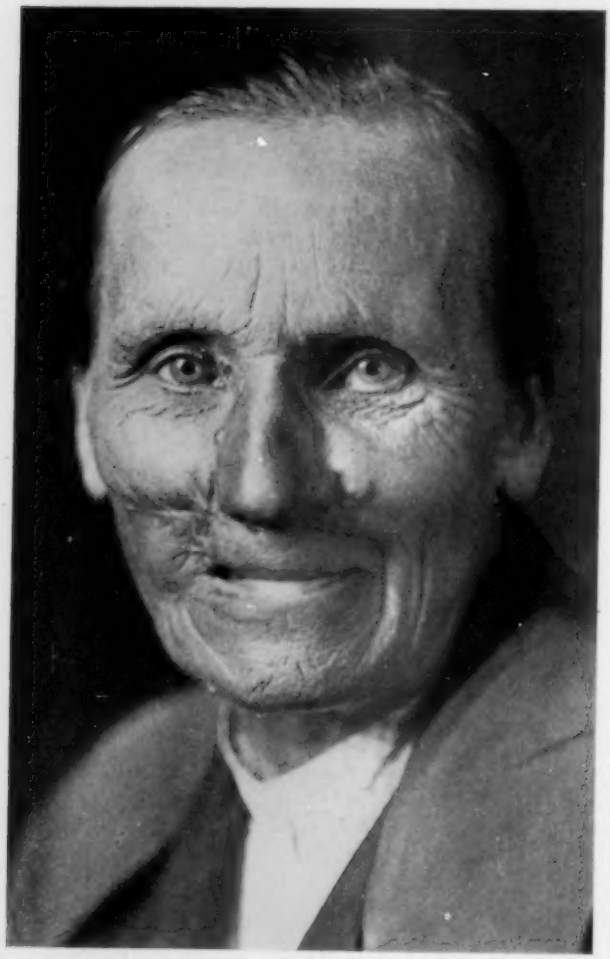

FIG. 2.—Showing condition of patient in September, 1914, six months after operation. No evidence of recurrence or signs of metastasis.

Since the location and extent of the mass made difficult its removal by the surgeon's knife; on account of the hemorrhage which would have been hard to control, it was decided to employ bipolar endothermy and the endotherm knife in attacking it.

With the patient under ether narcosis the growth was isolated from the surrounding

healthy tissue by a wall of coagulation necrosis at its base by the technic of bipolar endothermy. (See ANNALS OF SURGERY, vol. lxxix, Jan., 1924, p. 167.) Lymphatics, blood-vessels, and sensory nerves having been thus seared off, the endotherm knife was brought into use by a single turn of a switch on the endotherm. This current of exceedingly high frequency, operating through the same needle which had executed the coagulation wall, quickly excised the tumor without hemorrhage. A clean wound was exposed to which a vaseline dressing was applied.

Convalescence was rapid, there being, as usual, no secondary reaction and no evidence of surgical shock. Patient was able to take food well, the wound sloughed without interference, and nature set about granulating and filling in the excised tissue. No secondary hemorrhage. Wound healed in four weeks. One month later plastic operation was performed by Dr. Arthur M. Wright.

Reports of separate microscopical examinations by Dr. St. George and Dr. Douglas Symmers are subjoined.

Reports of Pathologists. I.—Frozen section; Clinical Diagnosis.—Tumor of mouth—possibly malignant. Pathological Diagnosis.—Infected epithelioma.

Specimen consists of flat crescent-shaped piece of tissue about 1 cm. in its longest diameter. On section the cut surface is dark brown in the upper portion and white at its lower edge. Frozen section shows marked inflammatory hyperplasia of the superficial epithelium associated with the presence of an acute inflammatory change in the subepithelial structures.

DOCTOR ST. GEORGE.

II. Clinical Diagnosis.—Tumor of lip. March 15, 1924. Microscopic examination shows the presence of a malignant new growth, the histology of which is slightly suggestive of adamantinoma and were the tumor located in the bone I should have no hesitancy in making a positive diagnosis of adamantinoma. The fact that the tumor was removed from the soft tissues in the vicinity of the lip however, renders this diagnosis highly problematical although one cannot entirely overlook the possibility of an adamantinoma of the soft tissues springing from congenitally misplaced enameloblasts. On the other hand I have seen many striking examples of changes in morphology occurring in metastatic growths, so that the secondary growth bore no resemblance whatsoever to the parent-growth and it is quite possible that the tumor in this particular patient represents a metastatic growth which has so changed its morphology as to resemble an adamantinoma.

The diagnosis of spindle-celled sarcoma must also be taken into consideration, although close inspection of the cells leaves me under the impression that they are epithelial and that the tumor belongs in the group of epitheliomata. There are so many possibilities to be taken into consideration that a positive diagnosis in my opinion at least, is not justified.

(Signed) DOUGLAS SYMMERS,
Director of Laboratories.

The manifest advantages of the employment of endothermy for the removal of such lesions as the one here described and illustrated are—the quickness and ease of its application, absence of hemorrhage, absence of surgical shock, absence of secondary reaction, minimum of trauma, and the reduction of the danger of metastasis and the likelihood of recurrence. Special mention should also be made of the benign feature of nature's quick healing after the malignancy is excised. These results are not, of course, casually achieved. They follow the employment of a definite, specific technic, for endothermy is technic as well as current. No other method enables us first to isolate the lesion and then to excise it by a cutting line which sears

as it cuts. How valuable is this method in the removal of tumors of body cavities as well as tumors of the body surfaces is just beginning to be understood.

GEORGE A. WYETH, M.D.,
New York, N. Y.

PRIMARY PNEUMOCOCCAL PERITONITIS

EDITOR ANNALS OF SURGERY:

Sir:

Acording to Rose and Carless, pneumococcal peritonitis is in the majority of cases secondary to a similar infection of the lungs or pleura, the organisms being transmitted by the blood or through the lymphatics of the diaphragm; less frequently the primary focus is in the pharynx or middle ear. Occasionally, they say, the trouble is apparently primary, the pneumococci finding their way through a healthy mucous membrane, as from the bowel or appendix, or more directly by the Fallopian tube.

The condition occurs most frequently in children, especially females, though the number of cases in adults is comparatively high. Lejars quotes a series of 106 cases collected by Jensen, in which 48 occurred in adults and 58 in children. In some cases, the disease is said to occur in an encysted form; in others, the course is acute and surgical interference urgently indicated.

Owing to the comparative rarity of the disease, the following case seems worth recording:

A male, aged eighteen years, was admitted to hospital with the history of having been taken ill suddenly the previous day with acute abdominal pain and vomiting. His bowels had been moved slightly. There was no diarrhœa, which is said to occur frequently enough to be an important diagnostic symptom. On examination, the lower abdomen was rigid and tender without any definite localising signs. The pulse was 104, and the temperature 102.2°.

The condition was thought to be probably appendicitis or possibly a perforation of an abdominal viscus, and an operation was performed immediately. The appendix appeared healthy, and no perforation of a viscus was discovered. There was much pus in the abdominal cavity and this was drained through a median subumbilical incision. Films of the discharge showed numerous bacteria, amongst which were Gram-positive diplococci resembling pneumococci. The patient made an uneventful recovery.

E. W. JOHNSON, M.D.,
Smithdown Road Hospital, Liverpool.

BOOK REVIEWS

Applied Pathology in Diseases of the Nose, Throat and Ear. By Joseph C. Beck, M.D. With 268 original illustrations, including four color plates. St. Louis, C. V. Mosby Company, 1923.

No new book on the ear, nose and throat has appeared for many a day with such a wealth of information compressed into one volume as this of Joseph Beck. The arrangement of the chapters may be quoted to show the author's conservative handling of his subject. They are divided thus: Anatomy, functions of the nose, diseases of the nasal chambers, atrophic rhinitis, miscellaneous conditions, the septum and the submucous resection, dips in the nasal bridge, development of the lateral wall, localized anatomy of the lateral wall, head-pains, turbinates, the ethmoidal cells, the sphenoidal cells, the frontal sinus, the maxillary sinus, coronal head sections. The number of illustrations, 268, is large for a book of 334 pages, and much that would occupy pages of text is graphically told by illustration and accompanying legend. The illustrations showing the anatomical development of the nose and nasal accessory sinuses are interesting.

The author emphasizes the value of carefully questioning the patient as to the precise location and nature of "head-pains"; and gives in detail diagnostic characteristics of these pains which may serve to distinguish differentially between sinusitis of the maxillary, frontal, anterior ethmoidal, posterior ethmoidal and sphenoidal cells; and between those lying in juxtaposition to the nasal ganglions and those situated more anteriorly; and also discusses "vacuum headache" and its relation to complaints of the eye, in which the author frequently finds the cause in diseases of the frontal and anterior ethmoidal cells. The book reflects the author's broad experience and matured judgment.

William C. Braislin.

Normal Bones and Joints, Röntgenologically Considered. By Isidore Cohn, M.D. New York, Paul B. Hoeber.

This volume represents the fourth of a series of monographic atlases of the ten which are to be eventually published comprising the *Annals of Röntgenology*, by various authors, edited by Dr. James T. Case.

A foreword by Rudolph Matas gives an excellent historical review of the development of radiography. The author has taken up the various appearances of the shoulder, elbow, wrist, hip, knee and ankle and illustrated with excellent plates the appearances seen at various ages, reviewing the literature in each instance and setting forth the observations based on the study of röntgenograms of the parts considered and interpretations of the pictures. In the

present volume, the translations into Spanish and French which were incorporated in the previous three, have been omitted, to the benefit of the volume as a whole. As a reference work, it will undoubtedly be greatly appreciated by the profession at large. JAMES T. PILCHER.

MEMORIAL NUMBER OF THE ANNALS OF SURGERY

WITH this issue of the ANNALS OF SURGERY for December, 1924, the journal completes forty years of publication. During this entire period the editing of the journal has remained under the direction of one man, the one under whose direction the first number was issued, Lewis Stephen Pilcher. As to the character of that direction the steady growth of the ANNALS OF SURGERY in the approval and support of the surgeons of the world is sufficient evidence. At the end of so long a period of such activity, to be still as vigorous and capable in the prosecution of editorial work, is a record which has been rarely equalled.

The publishers of the ANNALS have thought it sufficiently important to be marked by making the issue of January, 1925, a special number, which by its size, the character and number of its contributors, and the quality of its contents should in some measure indicate their appreciation of the eminent service rendered by its editor during so many years. They take pleasure therefore in now announcing that the January, 1925, issue of the ANNALS OF SURGERY will be one of special compliment to DR. LEWIS STEPHEN PILCHER to commemorate the completion by him of forty years of service as its Editor.

J. B. LIPPINCOTT COMPANY.

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